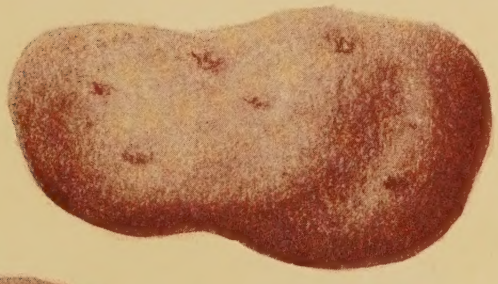
May 1968

THE POTATO INDUSTRY IN EAST PAKISTAN

Improving Seed Potato Multiplication and Storage



U.S. INTERNATIONAL AGRICULTURAL DEVELOPMENT SERVICE
U.S. DEPARTMENT OF AGRICULTURE
Cooperating with Agency for International Development

FOREWORD

In 1967, The East Pakistan Agricultural Development Corporation, a government agency, applied to the Agency for International Development (AID) for a loan to assist in the contruction of five seed potato cold storages. The storages would form the core of a seed improvement and multiplication program.

In order to help evaluate this rather specialized proposal, it was decided to send a three-man team to East Pakistan to gather further information on the potato industry and the proposed project. The team was established and operated in two steps.

First, arrangements were made with the International Agricultural Development Service (IADS) of the U. S. Department of Agriculture for the participation of an economist and a horticulturist. Drs. Dana G. Dalrymple of IADS and Robert V. Akeley of the Agricultural Research Service were selected. They carried out field studies in East Pakistan over a three-week period from November 6 to 24, 1967. Following their return, a draft report was prepared and discussed with AID/Washington and reviewed by the Mission in Dacca.

Secondly, arrangements were completed with the Bovay Engineers, a nation-wide consulting firm, for the services of an engineer. Mr. Gene McKay was selected and visited East Pakistan for a three-week period from February 6 to 23, 1968. Upon his return a separate report was prepared on the engineering aspects of seed storage, including detailed cost estimates and drawings. The report was reviewed with AID/Washington in mid-April 1968.

Based on material in the two reports and other sources, a third report on financial aspects appraisal was prepared by Dr. Dalrymple, and also discussed with AID/Washington in mid-April.

This bulletin presents essentially (1) the full report on economic and horticultural aspects, and (2) brief summaries of the engineering report and the financial analysis.* It is designed to provide a general reference for those concerned with the development of the potato industry in East Pakistan. The bulletin may also be of value to those who are interested in obtaining background information on potatoes for use in other tropical areas, or who have a broader concern with horticultural crops or seed improvement.

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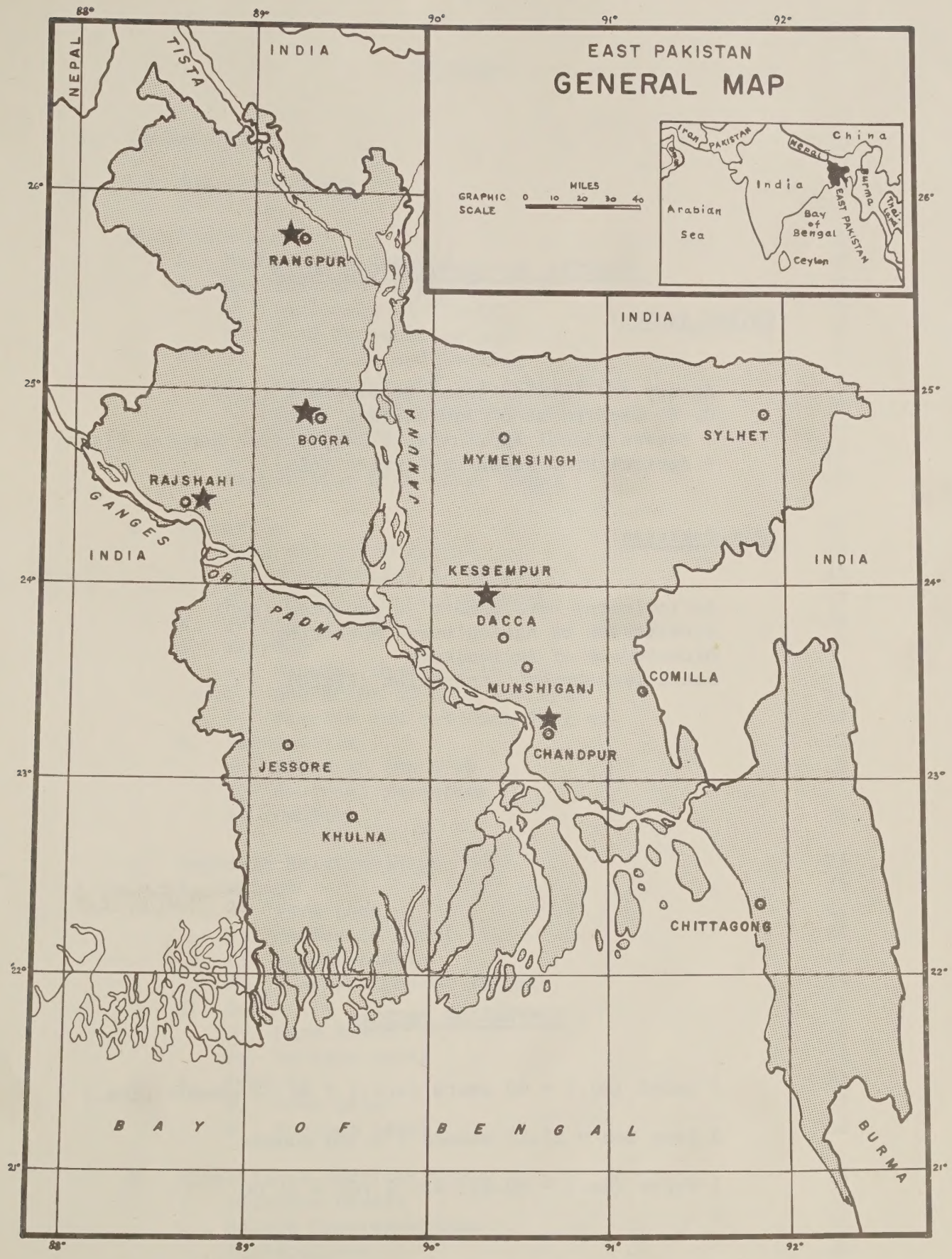
* Copies of the full engineering and financial reports may be borrowed from the International Agricultural Development Service.

Although every attempt was made to be as accurate and objective as possible, the report is not above error. There are possibilities of mistakes both in fact and interpretation. While inaccuracies are latent in any study, they are considerably more likely in a project of this nature -- particularly when human and organizational factors are not well known. The reader should be on guard.

The work of the team was greatly facilitated by the assistance and advice of many people, notably the AID/Agriculture Mission in Dacca. The names of the Mission personnel, as well as those of others who provided information to Drs. Dalrymple and Akeley are listed in Appendix A.



★ LOCATION OF PROPOSED COLD STORAGES

AGENCIES AND INSTITUTIONS NOTED

United States:

Agency for International Development (AID)
U. S. Department of Agriculture (USDA)
- International Agricultural Development Service (IADS)
- Agricultural Research Service (ARS)

East Pakistan:

Agricultural Development Corporation (ADC)
Directorate of Agricultural Marketing
Directorate of Agriculture
Small Industries Corporation (EPSIC)

CONVERSION FACTORS

1 maund (md.) = 40 seers (srs.) = 82.29 pounds (lbs.)

1 long ton = 27.22 maunds = 2.240 pounds

1 rupee (Rs.) = $0.21; Rs. 4.762 = $1.00

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THE POTATO INDUSTRY IN EAST PAKISTAN: IMPROVING SEED MULTIPLICATION AND STORAGE

by

Dana G. Dalrymple* and Robert V. Akeley**

I. INTRODUCTION

The white potato (Solannus Tuberosum) is not commonly raised in subtropical and tropical climates. In 1965, only about 8% of the world potato crop was produced in all of Africa, Asia (excluding Mainland China) and Latin America.1/ Potatoes are more generally grown in the temperate zones of the world where propagation and growth are favored by cool temperatures.

But in a world where hunger is concentrated in the subtropical and tropical zones, there is good reason for reconsidering potato production. Few, if any, commercially important crops equal the potential of the potato in terms of output of calories and other nutrients per acre. Even at present, the potato outproduces rice and other grains on this basis in East Pakistan.

Another and less urgent reason for considering the potato in subtropical areas is that it can provide variation in a diet which otherwise is often heavily oriented to one staple such as rice. In contrast to the United States, the potato is not considered as a staple in East Pakistan, but as a vegetable. It is relatively expensive and is almost a prestige item, especially in the urban areas.

Although the potato has been commercially cultivated for centuries in Europe and North America, it is evidently rather new to East Pakistan. One report indicates that it was first produced around 1930.2/ Since then, production has expanded substantially and potatoes are now easily the most important vegetable crop. Present production and marketing methods will be discussed in the first part of this report.

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** Potato Investigations Leader, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture

1/ Production Yearbook, 1966, FAO, Rome, 1967, p. 102.

2/ Haroun Er Rashed, East Pakistan, A Systematic Regional Geography and Its Development Planning Aspects, S. H. Ghulan Ali and Sons, Pakistan, 1966, p. 176.

One of the major production problems faced in East Pakistan -- and other tropical areas -- is the difficulty of building up and maintaining good stock. This is, in part, traceable to the heavy year-round insect populations which spread potato viruses. A special problem in East Pakistan is related to topography: the country is almost entirely a low-lying delta and there is essentially no high land suitable for more conventional breeding and multiplication programs.

One answer is to import new seed varieties each season. This process, however, takes scarce foreign exchange. A compromise method would be to import a limited amount of seed, multiply it, and then store it for distribution to farmers the following season. The latter method has been proposed for East Pakistan and will be discussed in detail in the second portion of this report.

It is hoped that this publication will make at least a small contribution to knowledge of potato production and marketing in the tropical and semi-tropical areas of the world.3/

3/ Some reports on the potato in other less developed countries are noted in Appendix C.

II. THE POTATO INDUSTRY

The potato industry in East Pakistan is in the process of expansion and improvement. Although current production and marketing practices generally do not reflect a high degree of development, there are winds of change in the air. Farmers are taking up the use of fertilizer, insecticides, and pesticides. Cold storages are being built at an increasing rate. Consumers are providing an increasing demand and economic relationships are favorable. These and other developments provide the background of the need for improvement in seed stock.

A. Production

Three major aspects of production are of particular importance (1) statistical trends, (2) horticultural characteristics, and (3) competition with other crops.

1. Statistical Aspects

The production of potatoes in East Pakistan has increased rather sharply over the past dozen years.[1/] Output during the 1965/66 and 1966/67 seasons averaged 538,400 long tons, over three times that of 1955/56 and 1956/57 (Table 1). This was brought about by both increases in acreage and yield. Acreage, however, more than doubled during the period while yield increased by only about half (and most of that was in the last two seasons). Yields in East Pakistan have been well below the average for the Far East and the world as a whole.[2/]

Within East Pakistan, production is scattered throughout the 17 districts. The seven leading districts in 1966/67 in terms of output were, in decreasing order: Rangpur, Dacca, Comilla, Bogra, Dinajpur, Mymensingh, and Rahshahi; together they accounted for about 63% of total production (Table 2). There was an inverse relation between total production and yield: except for Rangpur and Dacca, the seven leading districts were below the Provincial yield average; except for Pabna and Kushtia, the last ten districts were above the Provincial yield average. The range in yields was from a low of 2.34 long tons/acre in Mymensingh to a high of 5.65 tons/acre in Noakhali.

Among the 10 leading districts, the changes in production were quite variable over the 1960/61 to 1966/67 period. If the two seasons are

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1/ Yield data for Pakistan as a whole show a marked decline from 1949 to 1956, the later year marking the start of the data reported here for East Pakistan. (See Production Yearbook, 1966, FAO, 1967, p. 100; World Crop Statistics, FAO, 1966, p. 115.)

2/ In 1965, East Pakistan's average yield of 7,230 kg./hectare (2.88 long tons/acre) was well below the average of 10,200 kg./hectare for the Far East (excluding Mainland China) and 12,100 kg./hectare for the world (Production Yearbook, 1966, p. 102); comparable data are not yet available for 1967 when the Province's yield averaged 8,535 kg./hectare.

Table 1. ACREAGE, YIELD, AND PRODUCTION OF POTATOES, EAST PAKISTAN, 1955/56 - 1966/67

Seasons	Area (acres)	Yield (tons/acre)	Production (long tons)
1955/56	63,960	1.94	124,300
1956/57	71,735	2.64	189,500
1957/58	77,130	2.25	173,500
1958/59	87,735	2.55	223,900
1959/60	116,500	2.38	276,700
1960/61	137,800	2.46	338,300
1961/62	138,300	2.39	331,200
1962/63	142,700	2.50	356,600
1963/64	137,400	2.32	318,700
1964/65	137,400	2.88	395,400
1965/66	150,100	3.24	486,200
1966/67	173,840	3.40	590,570

Sources: 1955/56 to 1964/65. Agricultural Production Levels in East Pakistan, 1947-1965, Directorate of Agriculture, Bureau of Agricultural Statistics, 1966, pp. 234-237.

1965/66 to 1966/67. Unpublished data provided by the Bureau of Agricultural Statistics.

compared, the sharpest increases (over 100%) were found in Noakhali, Comilla, and Chittagong; substantial increases (50-100%) were found in Dacca and Sylhet; moderate increases (0-50%) in Rangpur, Dinajpur, Rajshahi, and Mymensingh; and a decrease (10%) in Bogra.

Behind shifts in acreage and yield lie changes in production and marketing practices. General production and marketing techniques will be discussed in the next few sections. District variations in the distribution of improved seed and the availability of cold storage will be given special attention in Sections III/A/3 and II/B/3 respectively.

2. Horticultural Aspects[3/]

The introduction of the potato and its cultivation into East Pakistan, as noted, dates back less than 40 years. The nature of the crop, the difficulties of production in the tropics, the lack of knowledge of disease control, and the small size of farm operations have created many problems over the intervening time. At present, perhaps most troublesome are the rapid decreases in yields caused by the "degeneration diseases" of potatoes.

a. Condition of Plants

During our trip to East Pakistan, we examined many potato fields with plants at different stages of maturity in Rangpur, Bogra, Dacca, Dinajpur, Mymensingh, Comilla, and Chittagong.[4/] Variety identification could not generally be ascertained; the northwestern and eastern districts, however, seemed to lean to the Burma variety.

Most of the seed stock used was either in its second or third generation of multiplication. Virtually all of the plants observed were infected with at least one virus. Two or more virus infections were likely since the plants were very small, stunted, and often showed considerable leaf-roll.

A potato plant, after its initial infection, gradually loses its vigor from one generation to another, eventually dropping off to 25% or less of its original yielding capacity. Our observations indicated the need for improvement in: adaptable varieties, seed size and selection, seed and row spacing, methods of application of fertilizer, disease control, and other factors.

3/ Background information on potato culture is provided by A. E. Kehr, R. V. Akeley, and G. V. C. Houghland in Commercial Potato Production, U. S. Department of Agriculture, Agriculture Handbook No. 267, July 1964, 59 pp.

4/ A detailed assessment of potato plants in the Comilla area was recently made by Gaylord Nelson: "Preliminary Report of Potato Consultant," Michigan State University (Pakistan Project), January-March 1967.

Table 2. ACREAGE, YIELD AND PRODUCTION OF POTATOES, BY DISTRICT, EAST PAKISTAN, 1966/67

District	Area (acres)	Yield (long tons/acre)	Production (long tons)
Rangpur	18,720	4.30	80,460
Dacca	15,800	4.91	77,560
Comilla	18,020	3.12	56,265
Bogra	18,730	2.90	54,355
Dinajpur	19,590	2.72	53,250
Mymensingh	22,160	2.34	51,920
Rajshahi	19,280	2.39	46,035
Noakhali	7,020	5.65	39,655
Sylhet	9,940	3.53	35,055
Chittagong	6,270	5.18	32,475
Khulna	5,000	3.93	19,655
Barisal	3,320	3.60	11,950
Pabna	3,540	3.01	10,665
Jessore	1,840	3.74	6,895
Faridpur	2,400	3.74	6,875
Hill Tracts (Chitt.)	1,260	3.56	4,490
Kushtia	950	3.38	3,210
TOTAL	173,840	3.40	590,570

Source: unpublished data provided by the Bureau of Agricultural Statistics, Directorate of Agriculture.

b. Land Preparation and Use

Usually the land is prepared by plowing from four to seven times, followed by laddering several times to break up the clots and smooth off the surface of the field. Bullocks or cows are used for draft power. The furrows for planting are made by a worker dragging his foot along the surface of the furrow and covering by hand with a spade. Rather pronounced ridges are built up at this time (they are rebuilt, if necessary, after each irrigation because the soil is likely to harden after water is applied).

There is a need to deepen the seed bed and reduce the compaction of the soil by farm animals. An inch or two of loose soil depth beneath the seed-pieces would give the plant roots a wider range for feeding and watering. The use of small hand operated roto-tillers could produce this extra depth and at the same time cause less compaction. The result would undoubtedly be improved yields.

In some districts it is customary to plant both early and late crops.[5/] The total yield is no greater than if only the regular crop was planted because (1) the early crop is harvested in 60 days at an immature stage, and (2) delaying the planting of the late crop lowers its yield. Total income however, can be greater under the two crop system because of the very high price received for the early crop.

To improve the fertility and the texture of the soil and the appearance of the tubers, it would be better if seed growers raised only one crop. This crop should be preceded by millet or some other fast growing cover crop which would be worked into the soil along with local manure prior to planting.

c. Seed Size and Spacing

Small seeds are commonly favored; in fact, a premium is often charged for them. The use of small tubers for seed, however, is detrimental as far as virus content is concerned, and will lead to reduced yields per plant. Ahmad and Quasem found a gradual increase in potato yields per plant with the increased in the size of seed pieces.[6/] They also found that cut seed pieces were more susceptible to soil-borne organisms and yielded less than whole seed of equal size (this may have been due to poor stands of the cut seed plots in their test.)

Ahmad and Quasem recommended planting seed pieces or whole tubers of one ounce in size. If healthy tubers are planted whole or cut and have proper suberization, the seed size could be increased to more than one ounce. The increased amount of seed used per acre could be reduced by varying the

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5/ Where this is done, the early variety is often of native origin.

6/ Ahmad Kamaluddin and Abul Quasem, A Study on the Performance of Different Sizes of Cut Seed Potato When Compared with Whole Seed Potato, E. P. Agricultural Research Institute, Division of Horticulture, Dacca, Horticultural Research Notes No. 6, July 1967, 16 pp.

spacing of seed in the row and the spacing between the rows.

Our observations revealed that the seed spacing varied from 6 to 12 inches between plants and 18 to 30 inches between rows. The average spacings were about 9 inches between plants and 24 inches between rows. The plant population is high for the closer spacings. It is made possible, in part, because of the dwarfness of the plants which are usually diseased. Healthier plants are grown from imported seeds and first generation cold storage seeds.

d. Fertilizer and its Application

Fertilization of the potato crop varies between areas and between methods of cultivators. Where fertilizer was used, the following types and rates of application seemed to be representative: triple superphosphate was spread at the rate of 1 to 3 maunds per acre while muriate of potash applications varied from 1/2 to 2 maunds. The usual practice was to broadcast and work both chemicals into the soil two days before planting. Urea was applied at the rate of 1/2 to 3 maunds per acre. Usually a split application was made. Part of the urea was broadcast before planting and the remainder used as a top dressing when the plants were about 6 inches high. The amount of cow dung worked into the soil before planting ranged from none to 200 maunds. Mustard oil cake was used at the rate of 3 to 20 maunds per acre. Usually one half of this material was broadcast before planting and the remainder placed in the furrow when the seed pieces were planted.

The Comilla Kotwali Thana Central Cooperative Association at Comilla recommends that their seed growers use the fertilizer ingredients and rates listed below. The complete mineral fertilizer program contains 130 pounds of soluble phosphate, 148 pounds of potash, and 57 pounds of nitrogen. Considering the high plant population, these applications are too low. Additional nutrients are supplied by mustard cake oil and cow dung, but

Source of Fertilizer	Maunds* per Acre	Available Nutrients	
		Percent	Pounds/Acre
Triple superphosphate	3	53 P_2O_5	130
Muriate of potash	3	60 K_2O	148
Urea	1-1/2	46 N	57
		Total Nutrients**	
Mustard cake oil	6	4-1/2 P_2O_5	20
" " "		2 K_2O	22
" " "		4 N	10
Cow dung	75	9 N	553
" "		2-1/2 P_2O_5	350
" "		6 K_2O	443

* One maund = 82 pounds
** Very slowly available

they are only slowly available. The exact rate depends on temperature, moisture, and bacterial activity in the soil, but even under the most favorable conditions, no more than 50% of the nutrients would be available during a three-month period.

The field broadcasting of most of the fertilizer before planting will decrease the availability of nutrients -- which in turn will hinder good early vine growth. A better method would be to place all the ingredients, except mustard cake oil and cow dung, in bands each side of the seed piece, two inches away from it and slightly below seed piece level. The mineral fertilizer should be applied at planting time so the plant can readily absorb the nutrient so necessary for early vine growth. Part of the nitrogen fertilizer should be applied in the form of ammonium nitrate which is more readily available to the plant early in the season than the nitrogen supplied by urea.

e. Insect and Disease Control

We did not get a very precise picture of the degree to which chemical insect and disease control measures are followed, but gathered that farm efforts generally are modest by U. S. standards.7/ Certainly the condition of the plants we saw would support this view. The government is encouraging control measures by making chemicals available at no cost to the farmers. Diathane and Malathion are evidently used for potatoes.

Although the growing season for potatoes is relatively dry, which helps to reduce insect numbers, the temperature is fairly high. The maximum mean readings during the growing season from October to March have varied from 74.3° to 88.8°F. Such temperatures are well suited for the multiplication of aphids, the insect vectors most responsible for transferring virus diseases. Early and late blight have been quite troublesome.

f. Irrigation

The use of irrigation for potatoes was very limited. Several tube wells were used in the Comilla area and limited water was available in the Dinajpur and Bogra areas. Most of the irrigation was done by hand from "tanks" or water left standing in low areas after the monsoon rains have receded. It is estimated that 90% of the acreage is dependent upon residual water in the soil.

From interviews with local cultivators and agricultural specialists, it seemed that the general practice for those who irrigate is to apply water four times during the season: (1) before preparing the land, (2) 35 days after plant emergence, (3) 55 days after emergence, and (4) 75 days after emergence.

7/ A somewhat more intensive program is followed by the farmers who belong to the cooperative at Comilla. The cooperative encourages control measures and makes small spraying units available.

This schedule is inadequate. While it is a good idea to irrigate before planting to reduce clotting and improve soil structure, water should be applied to the field soon after planting to hasten germination of the plants. Twenty-day intervals are too long; tuber size will fluctuate from little or no growth to very rapid growth, causing hollow heart, knobs, and second growth on the tubers. The latter symptoms were quite evident at one storage we visited.

Irrigation at regular intervals of 7 to 10 days will increase yields and reduce the chances of producing hollow heart and other tuber defects. Where tube wells have been or are to be installed, it would seem advisable to use this water more frequently than has been true in the past.

g. Yields

Although data are available on average yields by district and for the Province (Tables 1 and 2), no very reliable information appears to be available on relative yields of (1) imported, (2) cold storage, and (3) native seed. Evidently no closely controlled experiments have been conducted on the decrease in yield from imported seed through successive cold storage and production generations.[8/]

Yields are, of course, highest for the first generation imported stock. How high is not clear. A Dutch potato specialist who has traveled in Pakistan estimates that they are easily twice as high as for native seeds.[9/] Our own limited observations suggest that this may be a bit overstated. While we heard of figures as high as 200 mds./acre -- compared to an overall Provincial figure of 90 mds./acre over the past two years -- the average appeared to be closer to 120 to 140 mds./acre.

From discussions with several District Agricultural Officers we gathered that yields from imported seed decrease at the rate of 25% or more for each generation it is reproduced. After multiplication and cold storage for three generations, yields drop to about the Provincial average. This decline in productivity is rapid and is due primarily, we think, to the ravages of disease

3. Competition With Other Crops

Potatoes are raised during the Boro or what might be called the winter season. Usual planting, harvesting and marketing periods are listed in

8/ Ahmad has compiled sequential yield data from work done by others, but he does not feel that it is very reliable because the studies were not done under carefully designed or controlled methods. However, it was clear that (1) there was a considerable drop in the second and third generations, and (2) there was some varietal difference. (Kamaluddin Ahmad, A Study of the Performance of Potato Seeds in East Pakistan, As Obtained from Various Sources, E. P. Agricultural Research Institute, Division of Horticulture, Dacca, Horticultural Research Notes No. 4, July 1967, 11 pp.)

9/ J. C. Winkel, "Some Suggestions to Improve Seed Supply and Storage Facilities of Potatoes in Pakistan," Dutch Information Centre for Potatoes, The Hague, August 1967, p. 2.

Table 3. Boro is largely the "off-season" for rice because of an insufficiency of moisture. As a result, there is a relative abundance of fallow land. Where moisture permits, potatoes and other vegetables may be grown. The marketing system is not sufficiently developed to permit very widespread marketing of the more perishable vegetables. Potatoes are comparatively sturdy and can withstand the process relatively well.

Although Boro rice production was relatively unimportant for many years compared to the Aman and Aus crops, it is becoming increasingly significant. Over the five-year period from 1960/61 to 1964/65, Boro production represented only about 5.1% of the total crop; the proportion increased to 6.0% during 1965/66 and 8.8% during 1966/67. While the area planted to Boro rice increased somewhat, most of the increase was due to a growth in yield (from 0.48 tons/acre during 1960/61-1964/65, to 0.54 tons in 1965/66 and 0.60 tons in 1966/67). Both acreage and yield seem likely to increase in the future. The reason is threefold: (1) there is a continuing expansion in the amount of irrigation available, (2) new varieties of rice such as IR-8 are making substantially increased yields possible, and (3) recent high prices have proved an incentive to expand production.

Just how much direct competition there is between rice and potatoes at the production level is not entirely clear. The soil and water requirements of the crops differ somewhat: potatoes are better suited to a lighter soil and less water than rice, which has a much higher water requirement. Boro rice production has been concentrated in Sylhet and Mymensingh (79% of Provincial production from 1960/61-1964/65, 78% in 1965/66, and 70% in 1966/67), which raise a relatively small proportion of the potato crop (18% from 1960-61-1964/65, 16% in 1965/66, and 15% in 1966/67). On the other hand, the four northwestern districts of Rajshahi, Dinajpur, Rangpur, and Bogra raise a very small proportion of the rice (4% in 1960/61-1964/65) but a relatively large proportion of the potato crop (46% in 1960/61-1964/65, 32% in 1965/66, and 40% in 1966/67). On this limited basis, then, there would seem to be a relatively low level of competition in these districts. This was verified by our observations.

On the the other hand, where irrigation is available and the soil not too heavy, both can be grown; such is, to some extent, the case in Dacca and Comilla districts. Boro rice production in the two districts is fairly important and has been increasing (from over 10% of the Provincial total in 1960/61-1964/65, to 12% in 1965/66, to 15% in 1966/67); the same is true of potatoes (from over 15% in 1960/61-1964/65 to 23% in 1965/66 and 1966/67). The statistics, therefore, suggest a greater degree of competition. This is confirmed by our observations in the two districts. It appeared that some land planted to potatoes in Comilla Thana last year will be planted to improved rice varieties this year.

On balance, the competition between rice and potatoes in the cropping patterns may be increasing somewhat in certain eastern sections of East Pakistan, but is still not very widespread or substantial. What direction the future will take is not certain, but a leveling off of rice prices, difficulties with water supply, and a realization of the greater effort needed to raise the new varieties, could constrain farmer's interest in rice.

Table 3. USUAL PLANTING, HARVESTING, AND MARKETING PERIODS FOR POTATOES IN EAST PAKISTAN

	Unimproved Varieties 3/ (Desi)	Improved Varieties (Nainital)
Northwestern Area 1/		
Sown	Sept. - Nov.	Oct. - Dec.
Harvested	late Nov. - Feb.	Jan. - April
Marketed (peak)	Jan. - May	Jan. - May
Central - Southeast Area 2/		
Sown	Sept. - Oct.	Nov. - Dec. 4/
Harvested	late Nov. - Jan.	Feb. - April 5/
Marketed	Jan. - May	Feb. - May

Notes:

1/ Bogra, Rajshahi, Rangpur.

2/ Dacca, Comilla

3/ The earlier dates for sowing and harvesting often represent early plantings; the land is subsequently replanted for a double crop.

4/ Sept. - Oct. in higher sections where water has receded.

5/ Mid-Dec. - Jan. in higher sections.

Source:

Slightly modified from data provided by Directorate of Agricultural Marketing.

B. Marketing

The marketing process for potatoes in East Pakistan is quite different from that followed in the United States. In this section we will: (1) review present distribution patterns, (2) note some of the difficulties in transportation, (3) discuss storage in some detail, and (4) conclude with an examination of the nature of consumption.[1/]

1. Distribution Patterns

Distribution patterns can perhaps best be viewed by first presenting a hypothetical percentage breakdown between the major forms of utilization and distribution, and then outlining the major institutional elements involved in the marketing of potatoes.

a. Quantitative Breakdown

The East Pakistan potato crop is disposed of in three main ways: food; seed; and loss to shrinkage, spoilage, etc.[2/] We estimate that about 80% of the crop is consumed as food, 10% goes for seed, and approximately 10% is lost.[3/]

The crop takes two major directions after harvest. By far the largest portion -- we estimate about 70% -- goes into consumption. The smaller portion -- which we estimate to be about 30% -- goes into storage for seed or human use.

If the proportions cited in each of the previous paragraphs are combined, we would have the situation shown in Figure 1. Obviously the percentages are only approximate, but they do appear to be internally consistent with what few "hard" facts we were able to pick up on seed requirements, cold storage capacity, etc.

b. Institutional Framework

In East Pakistan, a sizeable proportion of the potato production does not enter the market channels: it is retained for home consumption or used as seed. Of that which leaves the farm, most is sold locally -- directly to neighbors or on the nearby village market. According to one estimate, the quantity of potatoes leaving the local area is only about one third

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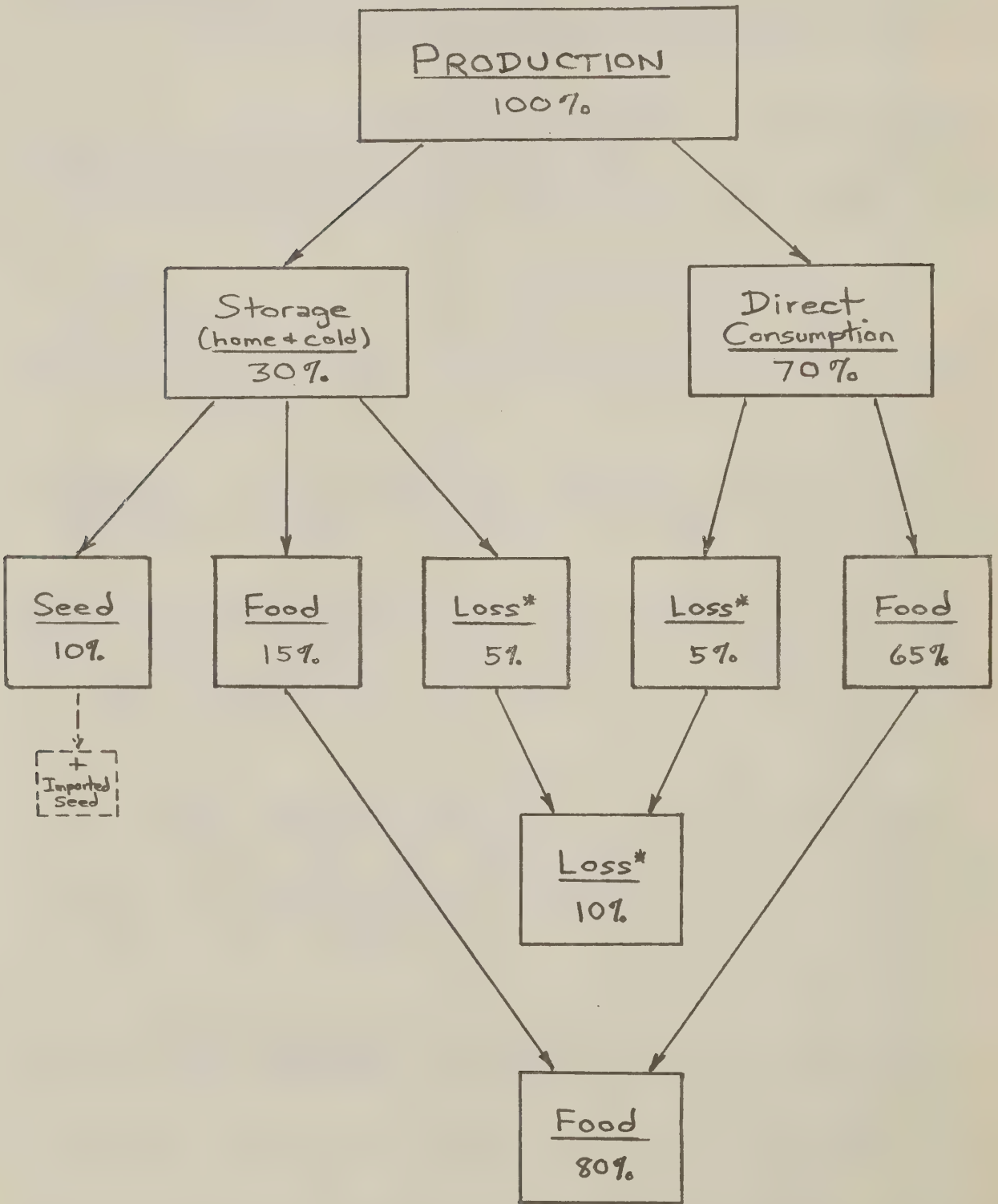
1/ A more general review of produce marketing is presented in "Present Fresh Fruit and Vegetable Marketing Practices in East Pakistan," CENTO Traveling Seminar on Fresh Fruit and Vegetable Marketing, Central Treaty Organization /1966/, pp. 15-27.

2/ Essentially none appears to be used for livestock feed or the manufacture of starch or alcohol.

3/ The loss percentage may seem low, and perhaps it is. But it was our observation that very little food is completely lost. If there is rot in a potato, it is cut out and the rest consumed. What is discarded by one, may be consumed by another. Food is short, and available supplies are stretched a long way.

Figure 1. ESTIMATED UTILIZATION OF POTATO PRODUCTION IN EAST PAKISTAN



* Handling loss, waste, and shrinkage; see text footnote 3, page 13.

of production.[4/]

For that portion moving to more distant markets, the institutional framework is a bit more complicated. A diagrammatic outline is presented in Figure 2. One of the main distinguishing characteristics is the presence of the Bepari, a man of many functions. Usually he procures supplies from individual farmers (or possibly local farm markets), assembles them, and transports them to the wholesaler or the Aratdar. The Bepari generally acts as an agent for one or the other, and receives credit from them for payments to farmers. His function may in somecases be performed by a local cooperative organization.

The wholesalers and the Aratdars (or broker) have their western counterparts. Traditionally, the East Pakistan wholesaler provides only temporary warehousing. However, the wholesaling function is taking on new form with the consturction of cold storages. Many of the storage operators, as we shall note later, buy potatoes which they in turn sell wholesale. Or they may rent space to other wholesalers or to Aratdars. The double-ended arrow between the wholesaler and Aratdar in Figure 2 indicates that there may be some interchange of potatoes.

The sale of potatoes in retail stores is a rather specialized function. Typically potatoes are sold with a limited quantity of other dry vegetables such as beans. During harvest season, itinerant retailers may set up shop for a relatively brief period. In an urban market such as Dacca, a small amount may also be sold by local growers on farmer markets.

Data are not available on the quantities of potatoes flowing in each channel, but the Producer→Bepari→Aratdar→Established Retailer channel is probably the most prevalent, while the Producer→Wholesaler (cold storage)→Established Retailer route will likely increase in importance.

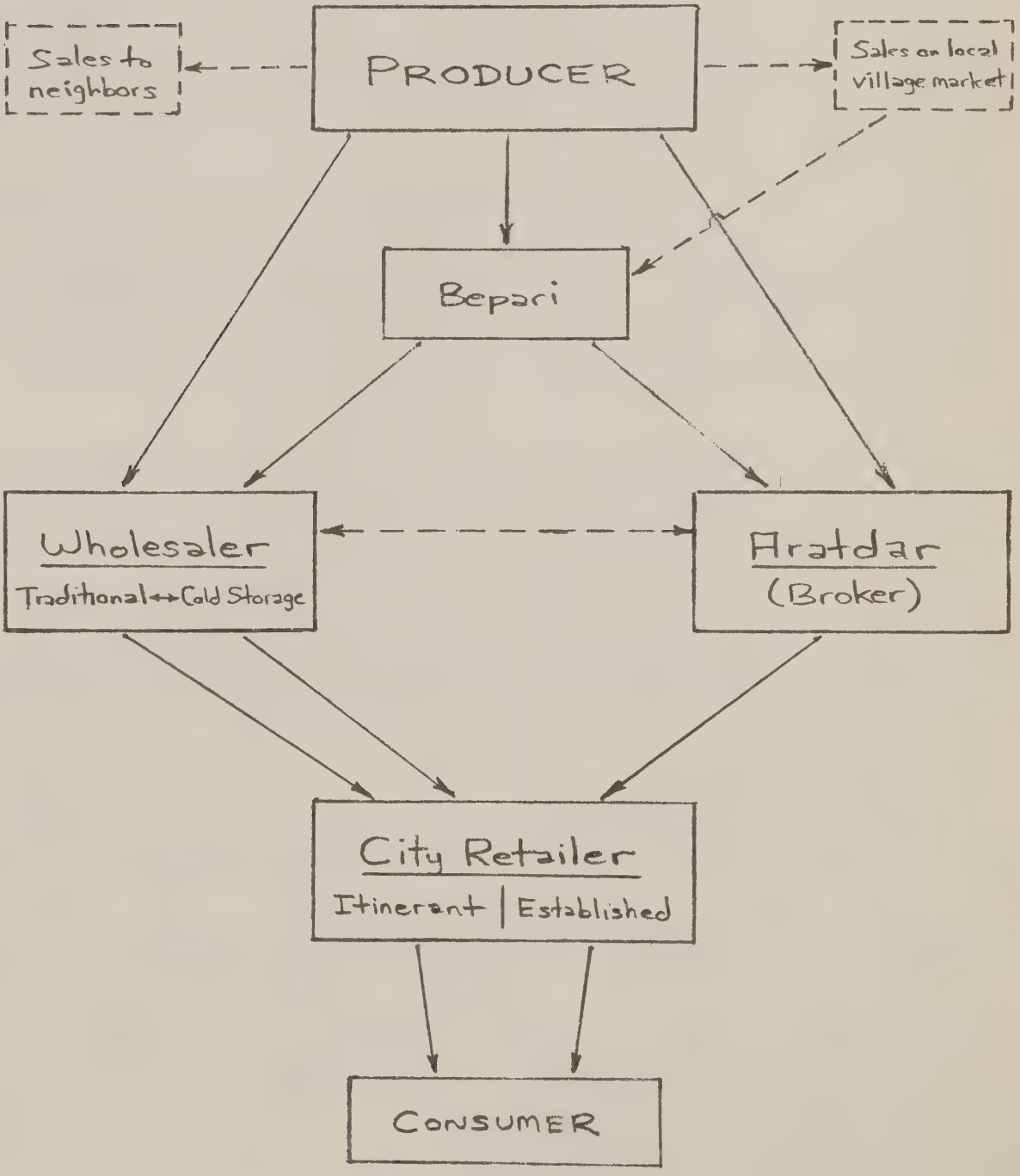
2. Transportation

Transportation in East Pakistan presents an unusual set of difficulties. The result is a definite influence on production and marketing patterns.

On one hand, the many rivers and the annual flooding of much of the country provide a unique opportunity for boat transportation. Boats typically can move a large volume at a low price. But in East Pakistan virtually all are "sailboats," and move very slowly. The speed can be of considerable importance in some cases because temperatures are typically high and none of the boats has refrigeration. This virtually eliminates them for the more perishable crops, but does not greatly hamper their use for potatoes. While we do not have any data, we would suspect that sailboats account for most of the transport of potatoes. Some cold storages receive virtually all of their potatoes in this way.

4/ Survey Report on Requirements of Cold Storages in Pakistan, Ministry of Agriculture and Works (Rawalpindi), Department of Marketing Intelligence and Agricultural Statistics, S.S. VI, August 1966, pp. 7-8.

Figure 2. GENERALIZED INSTITUTIONAL FRAMEWORK FOR THE MARKETING OF POTATOES IN EAST PAKISTAN



Source: Modified from "Marketing of Potato in Dacca City," Marketing of Selected Food Articles in Dacca City, Dacca University, Department of Commerce, 1966, pp. 105. (A preliminary survey kindly provided by Dr. A. Farouk.)

The other side of the picture is that the many waterways severely limit other forms of transportation. The cost and difficulty of building roadbeds and bridges (especially in a country which has virtually no rock or gravel) limits railway and highway construction. There are no bridges across the major river systems that divide the eastern and western portions of the country, so that ferries have to be used. Furthermore, the railways are of different gauges on either side, so that cargoes have to be reloaded. The highways are narrow and very crowded with people, rickshaws, carts, livestock, etc. so that fast movement is severely hampered. As a consequence, overland movement of movement is slow and expensive -- but the only recourse in some areas. The result is that the movement of potatoes can be rather expensive.

On a local level, the potatoes that cannot be transported by boats are carried by humans or pulled by bullocks. The range and speed of both is limited. Most produce, therefore, goes no further than the local village market. There, some of it may be assembled by the Beparies, or their counterparts, and then transported by boat or truck to more distant markets.

3. Storage

Storage is an essential factor in the maintenance of the quality of seed potatoes and is of growing importance in the marketing of table stock potatoes. The two major forms are home storage and commercial refrigerated storage.

a. General Characteristics

It may be helpful first to outline some of the major economic, and physical and biological characteristics of these two methods of storage.

- Economic Dimensions. The previous section has indicated that perhaps 30% of the potato crop has been stored during the last season or two. Our crude calculations suggest that possibly nine-tenths of this represents home storage for a month or more,[5/] and that one tenth represents commercial refrigerated storage.

Of the quantity placed in home storage, we estimate that nearly 20% is lost due to shrinkage, spoilage, rats, etc. Out of the remainder, perhaps 50% is used for food and a little over 30% for seed.

The breakdown is somewhat different for cold storage, with spoilage and shrinkage probably accounting for a little over 5% and with the remainder approximately equally divided between table and seed stock.[6/]

5/ Precise definition of "storage" is a bit difficult in the case of home storage. The physical characteristics of a medium-term home storage rack will be described in the next section. However, storage could also be of a short-term nature and just involve keeping the potatoes in a sack in the corner of the home or under the bed.

6/ It is very difficult to determine the precise breakdown. Many of the storages were established with the understanding that they were primarily for seed. Hence there is a tendency for the operators to over-report seed holdings and under-report table holdings.

If tentatively accepted and applied to the 1966/67 season, the above proportions suggest that about 177,000 long tons of potatoes were stored -- over 159,000 in home storage and nearly 18,000 in refrigerated storage.[7/] Spoilage and shrinkage probably took almost 30,000 tons, while around 89,000 may have gone for food and up to 59,000 for seed.

These calculations, as pointed out earlier, are extremely rough. No one knows the true figures. But they may be reasonably accurate as approximate measures of magnitude.

- Technical Dimensions. The major types of potato storage in East Pakistan -- home and refrigerated cold storage -- naturally differ quite sharply in their major technical characteristics. Home storage is a rather small scale and primitive process. It usually consists of an outside elevated rack or platform on which potatoes are placed in layers of sand. On the other hand, the refrigerated storages are large -- generally 1,000 long tons -- and relatively sophisticated.[8/] They are quite similar to fruit storages in the U.S., except that they contain three tiers of ventilated wooden racks, each slightly taller than a man. The potatoes are placed in 180 lb. jute sacks and stacked five or six feet high.

The length of storage period, of course, differs with each type of storage. Home storage is relatively short-run in nature. Native (unimproved) varieties of potatoes evidently hold up fairly well from harvest through the onset of monsoon in mid-summer. Thereafter, deterioration is heavy and the potatoes are held more for seed than for table purposes. The potatoes are checked regularly during the season and those which are not felt to be suitable for seed are consumed. Rats are often a problem. The improved varieties of potatoes do not hold up at all well in home storage; on the other hand, they do well in cold storage and will keep for up to eight months with relatively little sprouting. Nearly all of the potatoes placed in cold storages are second or third generations of, or descendents of, improved varieties.

b. Operation of Cold Storages

The refrigerated cold storages -- totaling 23 in the fall of 1967 -- are typically "...owned by individuals under the names of private limited companies."[9/] One is a cooperative.

7/ Total physical capacity on September 1, 1967, was 18,566 tons. Not all of this was used for potatoes. Small quantities of fruit were held and one storage kept several hundred tons of new IR-8 rice seed.

8/ In the U.S., the cold winter temperatures in many of the major potato producing areas make it unnecessary to refrigerate -- in fact the purpose of the storage is to keep the temperature high enough so that the potatoes don't freeze. Heating is usually required in the northern United States.

9/ Survey Report, op. cit., p. 11. Most of the storages also manufacture ice.

Space is distributed in several ways. First, the cold storage operator may buy potatoes directly or through a Bepari; these are held for sale either as table stock or seed. Secondly, traders or speculators may rent space and buy potatoes for similar purposes. Thirdly, growers or more generally groups of growers may rent space, largely for seed potatoes. During the 1962/63 to 1964/65 period, it has been estimated that the space was divided as follows: proprietors 75.5%, traders 4.0%, and growers 20.5%.10/ More recently it has been estimated that the proportion of space rented by growers has increased. (In fact, in one rather extreme case involving four storages in the Munshiganj area of Dacca district in 1967, 61% of the space was rented by growers.11/)

We do not have a complete record of the rental storage charge, but it generally appeared to run between Rs. 12-13 md.12/ In some cases the handling charge is included, in others, it is extra (Rs. 1.2/md. for one storage). The price was a flat charge for the season; there were no discounts for shorter periods. One storage we visited would not deal with small individual farmers because of the inventory control problem, but would rent space to village groups which have 200 md. or more to store. When the storage operators purchase potatoes, they usually do so on a graded basis and provide the sack.

Generally, loading of the storages starts around the first of March and runs through the end of April. Out-of-storage movement of table potatoes begins with the onset of the monsoon in mid-summer (when the quality of home-stored potatoes drop off) and reaches a peak from mid-September to early November.13/ Seed stock usually moves out from mid-October through late November. Exact dates vary with the earliness and lateness of the season and the location of the storage.

Most -- if not all -- of the storages are cooled by ammonia compressors. The temperature is usually maintained at from 34 to 37°F. The storages do not have formal humidity control systems, but they often have a dry and wet bulb thermometer for measuring humidity. If the moisture level gets too low, water is applied to the floor or, in some cases, to the racks. No provision is made for ventilation with outside or fresh air, except as the door is opened.

The potatoes are first placed in a precooling room where the temperature is maintained at 47 to 50°, and then moved into the main room. They are

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10/ Ibid., p. 12.

11/ From records gathered by A. K. Mansur, Dacca District Agricultural Officer.

12/ This is the equivalent of about $3.30/cwt., at least ten times the average rate in the United States. (But as noted earlier, U.S. storages are not refrigerated.)

13/ The sale season is rather short at present -- two or three months. As capacity increases the sales period may move backward into the summer.

stored in 180 lb. bags (2 md./10 srs.). All movement is done by hand. At the end of the season, the bags are moved into the precooling room for a few days or a week, and then taken outside. Despite the higher temperatures in the precooling room there is still a marked differential between it and the high outside temperatures, causing moisture condensation or sweating. To handle this, the sacks are opened, the potatoes laid out on the storage platform, and dried for several days with ceiling fans. This process is called "declimatizing." During this period, the poor potatoes are usually picked out. The potatoes are then rebagged and moved to field or market.

Although the existing storages do a reasonably good job of holding potatoes for the table market, they have several weaknesses as far as seed storage goes. These center about the lack of (1) uniform temperature, (2) humidity control and (3) fresh air ventilation.14/ Uniform temperature and humidity within the storage room reduce sprouting and rotting of tubers. Forced air ventilation with fresh air intake is desirable to maintain seed quality and to reduce internal blackheart.

c. Storage Construction Program

The 1967 cold storage capacity of nearly 20,000 tons is expected to be increased by about four times in the next few years. Current construction which have received sanction will add another 43,000 tons or more.

Foreign exchange financing for the cost of imported machinery is being handled through two groups. One is the East Pakistan Small Industries Corporation (EPSIC). It is backing a block of about 27 privately-owned storages through a $1 million loan from AID. Bids were received for the machinery in November 1967 and construction was expected to start shortly, with completion scheduled in late 1968 and early 1969. Thus in one fell swoop, storage capacity will almost double! The other agency providing financing for imported machinery is the Industrial Development Bank of Pakistan (IDBP). The storages they are backing, however, are individual projects and are not all being built at the same time.

Insofar as potatoes are concerned, an important factor will be the location of these storages. In Table 4 we have attempted to summarize by district the proportions of (1) potato production in 1966/67, (2) existing capacity in September 1967, (3) prospective total capactiy as estimated by the Directorate of Agricultural Marketing, and (4) present and proposed total capacity approved by EPSIC and IDBP. If all the space were used for potatoes, present storages could hold only 3.3% of the crop; under the estimates of future capacity, the figure would be between 13 and 14%.

14/ Our observations were shared by those of a Dutch potato specialist who visited a number of storages in June and July of 1967. He reported that "the main part of the potatoes was kept at a temperature well above the reading on the control thermometers." (Winkel, op. cit. /see fn. 9, p.10/, pp. 5-7.) Further technical details on current practices, as reported by an American engineer, are reported on pp. 69-70.

Table 4. DISTRIBUTION OF POTATO PRODUCTION AND PRESENT AND PROSPECTIVE COLD STORAGE CAPACITY, EAST PAKISTAN, 1967

District	Proportions of Potato Production 1966/67	Present Cold Storage Capacity[2]	Prospective Storage Capacity[1] Estimated by DAM[2]	Prospective Storage Capacity[1] Sanctioned by EPSIC & IDBP[3]
Rangpur	13.6%	0	3.7%	1.3%
Dacca	13.1	43.2%	53.4	54.2
Comilla	9.5	8.8	5.8	9.1
Bogra	9.2	8.1	3.7	2.1
Dinajpur	9.0	5.1	1.2	1.3
Mymensingh	8.8	0	2.5	3.9
Rajshahi	7.8	0	1.2	1.3
Noakhali	6.7	0	1.2	2.6
Sylhet	5.9	6.1	3.9	5.7
Chittagong	5.5	12.8	12.3	4.5
Khulna	3.3	5.6	5.0	5.8
Barisal	2.0	5.1	1.7	1.7
Pabna	1.8	0	0	0
Jessore	1.2	5.1	2.2	2.3
Faridpur	1.2	0	0.2	1.6
Chittagong Hill Tracts	0.8	0	0	0
Kushtia	0.5	0	1.8	2.6
TOTAL	100%	100%	100%	100%
	(590,570 tons)	(19,566 tons)	(81,250 tons)	(77,100 tons)

Notes

1/ Includes existing storages and storages under construction (the latter was estimated at 13,700 tons on September 1, 1967). Excludes proposed ADC seed storages.

2/ Estimate made by Directorate of Agricultural Marketing as of September 1, 1967. Proposed units include those for which papers have been filed and were being "processed" as of November 1967.

3/ Approved for financing as of mid-November, 1967; not all will actually be built. Standby approvals were provided for units in Jessore and Comilla.

On a district basis, several points are worth noting. In the Dacca district, capacity will increase from 43 to 53-45% of the Province's total. Clearly, potatoes are being -- and will likely continue to be -- shipped in from other districts. At the other extreme, the four northwestern districts of Rangpur, Bogra, Dinajpur and Rajshahi accounted for nearly 40% of 1966/67 production but had only 13% of storage capacity in 1967, and are likely to have only 6-10% in the future. Mymensing and Noakhali will also rate relatively low on capacity. Other districts will be more evenly balanced.

In recent years it has been thought by some that production growth has followed increases in storage capacity. A review of production changes during the 1960's and 1967 storage capacity does not entirely bear this out.15/ It is true that Dacca, Chittagong and Comilla were well supplied with storage and production has increased considerably -- but they were the areas best supplied with the imported Holland seed (see pp. 40-43). Thus there was a certain amount of intercorrelation. Both storage and seeds were involved.

4. Consumption

The final stage in the marketing chain is consumption.

a. Place in the Diet

The potato appears to occupy quite a different position in food consumption patterns in East Pakistan than it does in the United States. In the U.S., potatoes are regarded as a low-cost year-round staple, distinct from other vegetables. In East Pakistan, except for possibly a short period during harvest season, the potato is neither low-cost nor a staple; these distinctions go to rice. Rather, potatoes are looked upon as a vegetable and are used to add variety to the diet. In the urban areas, potato almost seem to have the status of a "superior" food. Indeed, one survey found that "... in urban areas increases in income are accompanied by greater consumption of starchy roots."16/ The situation in rural areas is less clear.

Still, potatoes are reportedly consumed in one form or another by all classes of the population. Essentially the whole crop is sold in fresh form; only a very small quantity is processed into sticks or chips for sale in urban areas, especially in movie theatres. The fresh potatoes are used in the home in one of several ways: in a fish or vegetable curry, in mashed (or as the Pakistanis say, "smashed") form, or fried into sticks or chips (the latter are more common in the urban areas).

15/ The procedure can only be rough because it doesn't take into account the specific location of the storages.

16/ Nutritional Survey of East Pakistan, March 1962 - January 1964, U. S. Department of Health, Education and Welfare, Public Health Service, May 1966, p. 108.

A very rough estimate of per capita potato consumption in 1965 would be about 11.3 lbs. (5.1 kg.) per person.17/ Consumption appears to be higher in rural than urban areas -- possibly almost twice as high.18/ In view of the widespread production of the potato, the limited cold storage, and the difficulties of transportation to urban market, higher rural consumption is not at all unlikely.

b. Seasonal Variation

The consumption of potatoes in East Pakistan is, as might be expected, very seasonal: it is high during the harvest season but relatively low during the rest of the year. This is, of course, traceable to the difficulties of home storage and the limited amount of refrigerated cold storage. The result is that it is somewhat misleading to talk about average annual figures: there is not one but two dimensions to the matter of consumption.

The magnitude of the seasonal difference is suggested in a comprehensive nutritional survey that was conducted several years ago.19/ The report revealed that in 17 rural locations, about two-thirds of the consumption of starchy roots took place in the three-month period from March to May; inclusion of February and June raised the total to 85%. During the peak three months starchy roots represented nearly 15% of total per capita food intake; during most of the rest of the year they averaged 1.5 to 2.0%.

The obvious problem with these figures is that they are not specifically for white potatoes. However, slightly over half of the starchy root category is made up of white potatoes; the remainder is largely composed of sweet potatoes which are understood to be harvested later than white potatoes.20/ This suggests that perhaps the peak of white potato consumption is reached in March and April -- at which time it might represent up to 10% of total per capita food consumption in the rural villages. The remainder of the year it may be little over 1%. Specific comparative data were not reported for urban areas, but presumably they follow much the same pattern.

Consumption of other vegetables is evidently also very seasonal -- with much of the production coming to market in the Boro season along with early potatoes.

17/ The Food and Agriculture Organization has estimated that for Pakistan as a whole during the 1957/58 to 1959/60 period, when production in East Pakistan was about 57% of 1965, per capita consumption was about 3.7 kg. (7.2 lbs.) (Food Balance Sheets, 1963). By comparison, per capita consumption of potatoes in the U.S. has averaged about 110 lbs. in recent years (The Vegetable Situation, USDA, November 1967, p. 26).

18/ Nutritional Survey, op. cit., pp. 210-211, 214-215.

19/ Ibid., pp. 173, 210-211, 214-215.

20/ The East Pakistan sweet potato is quite different from that raised in the United States. It is white rather than yellow fleshed, much more fibrous, and considerably less sweet.

c. Outlook

The consumption of potatoes is not likely to diminish in the future in East Pakistan. On a per capita basis, consumption will probably at least hold steady and may well increase if income levels should grow.21/ The prospective sharp increase in cold storage holdings should make it possible to increase consumption later in the season.

Projected population increases should further expand overall demand. The total population, according to one commonly used projection, will increase from 63.3 million in 1965 to 83.7 million in 1975 (a growth of 32%) and 112.5 million in 1985 (a growth of 78%). The urban portion of the population, currently 5.4%, will grow slightly.22/ Clearly, there is going to be a substantial increase in the need for food.

In a more general sense, it should be recognized that as output of food-grains -- particularly rice -- approaches desirable levels in the future in southeast Asia, there will be increased interest in diversification of farm output to include a greater quantity of fruits and vegetables.23/ Potatoes may well be the precursor of that trend in East Pakistan.

21/ Income elasticities of demand are discussed on pp. 29-30.

22/ James W. Brackett and Donald S. Akers, Projections of the Population of Pakistan by Age and Sex: 1965 - 1968, U. S. Department of Commerce, Bureau of the Census, June 1965, pp. 9, 27. (Projection B. Declining fertility, constant mortality.)

23/ See Asian Agricultural Survey, Asian Development Bank (Manila), Vol. I (Regional Report), March 1968, pp. 71-72. (Official Use Only)

C. Economic Relationships

We now turn to a more detailed examination of economic relationships for potatoes. This will involve review prices at various levels in the marketing process and of costs and returns. The data are all too scarce and fragile to permit many firm conclusions.

1. Prices

Prices are reported, to varying degree, at the farm, wholesale, and retail levels. Nearly all of the basic data have been collected by the Directorate of Agricultural Marketing. Two price series are generally reported: (a) for the Desi (a generic term for unimproved native varieties), and (b) for the Nainital (a generic term for improved varieties or distinguishable progeny thereof).

a. Farm Level

No systematic record has been kept of farm prices for potatoes until just recently. During 1966 (effectively the 1965/66 season), the Directorate of Agricultural Marketing initiated a survey of harvest-time prices at primary farm markets. It revealed that the average prices were Rs. 14.74/md. for Desi and Rs. 15.50/md. for Nainital. For previous years, the Directorate has estimated prices by making a deduction of Rs. 1.5 to 2.0/md. from wholesale prices. Over the ten-year period from 1957 to 1966, this process suggested that the average price for Desi was about Rs. 13.6/md. while that for Nainital was Rs. 17.3/md. There was a slight increase in prices for both types during the period, but the premium for Nainital has gradually narrowed.

To get an average overall harvest-time price, we would need to know the relative quantities of both Desi and Nainital. Unfortunately there is no information on this point. If we assume that 90% of the potatoes sold during this period were classified as Desi and 10% Nainital, then the average harvest-time price would have been about Rs. 14.0/md. for the period from 1957-1966, and Rs. 15.0/md. for the 1962-1966 period. If the proportion of Nainital was higher, then the average price would have been higher.

Still, the figures of Rs. 14 to 15/md. would seem to be in line with the scattered average harvest-time price estimates that we received.[1/] As potatoes begin to move out of storage, the average price of course climbs. Early season potatoes -- those which are harvested in November and December -- bring particularly high prices. Thus, the season average price should be somewhat higher.

b. Wholesale Level

Rather comprehensive data are collected on wholesale prices for potatoes. The Directorate of Agricultural Marketing makes weekly surveys of prices

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1/ This would be equivalent to $3.57 to 3.83/cwt., well above U.S. farm prices.

in 24 regional wholesale markets. Unfortunately the Directorate has heretofore not had the resources to pull more than a portion of this data together on a monthly or annual basis.2/ But they have made some tabulations and others have been prepared by the Central Statistical Office in Karachi.3/

- Annual Variation. A yearly index of wholesale potato prices has been published by the Central Statistical Office for the fiscal year from 1956/57 to 1966/67, with 1959/60 = 100. It is presented in Figure 3. The graph reveals a gradual increase in prices, with a high point reached during the 1964/65 fiscal year. It will be recalled (Table 1) that during the same period, production also increased.

- Monthly Variation. Similarly, a monthly index of prices has been prepared, with the 1959/60 annual average equal 100. Data for three recent fiscal years are presented in Figure 4a. Clearly, there was a very sharp fluctuation in prices. Prices dropped heavily through the harvest season, from a high of nearly 200 in October and November, to a low of about 60 in February. They then rose gradually through the remainder of the season.

Seasonal trends may also be viewed in terms of actual monthly prices for Nainital over five recent caledar years (Figure 4b). The price data confirm the general trends shown by the indexes. Actual prices seemed to range from a low of about Rs. 14.4/md. in February to a high of Rs. 41.4/md. in November -- a change of about 2-1/2 times.4/ It is expected that this range will be reduced in the future as cold storage capacity increases.

- Geographic Variation. There is considerable variation in regional prices. Data from the Directorate of Agricultural Marketing reveal that during 1965 and 1966, average harvesting period prices in the northwestern districts of Bogra, Rangpur and Rajshahi averaged perhaps one-third higher than in the central district of Dacca.

c. Retail Level

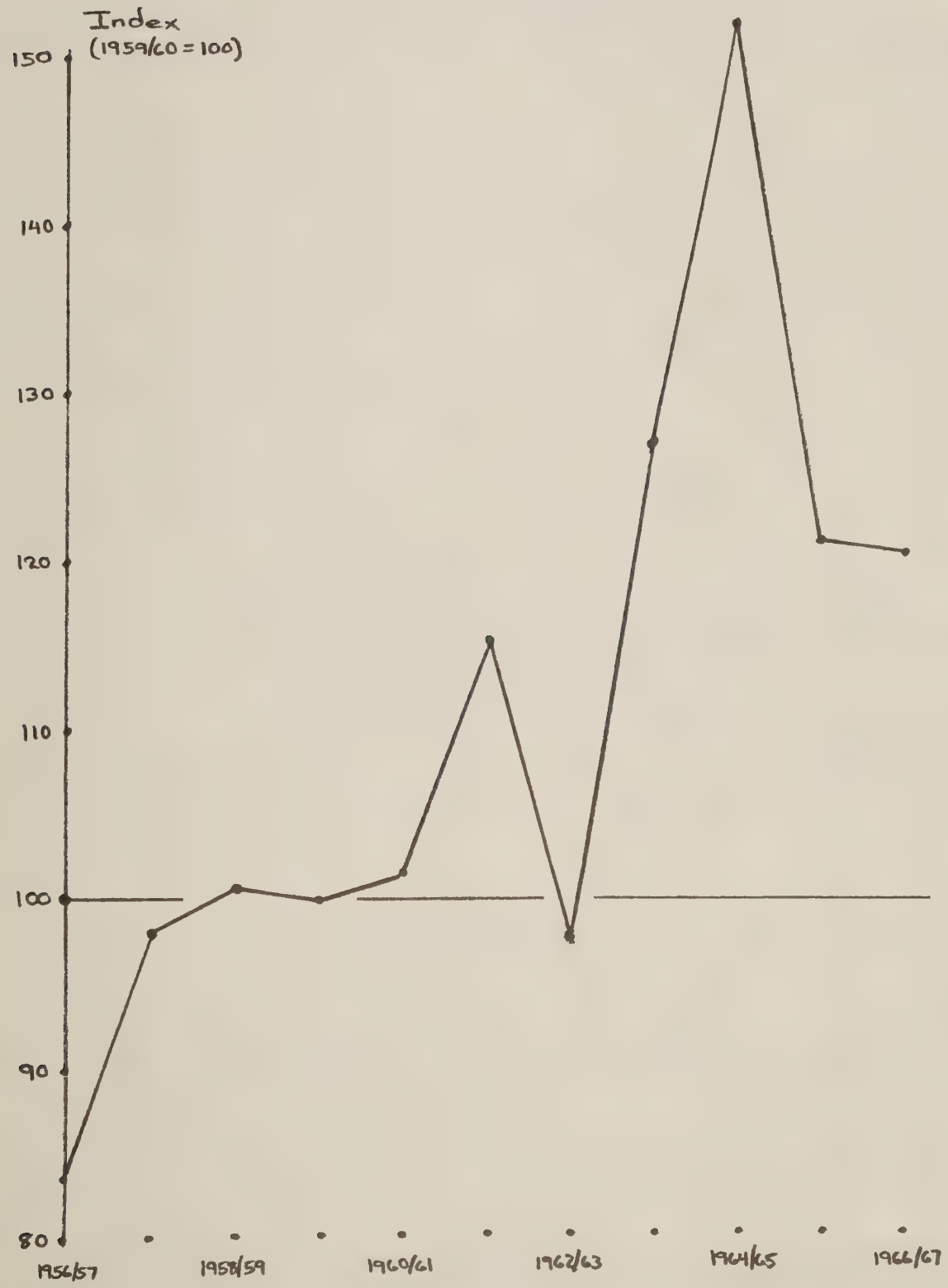
Very limited information is available on retail prices. However, data obtained in 1965 and 1966 by the Directorate of Agricultural Marketing for the northwestern and central districts noted in the immediately preceding section suggest that they may have averaged about Rs. 3/md. higher than wholesale prices. They appeared to average slightly more than this in Dacca, and slightly less in the northwest districts.

2/ Starting in 1968, the Directorate expected to have a substantially enlarged research staff.

3/ Monthly Statistical Bulletin, Government of Pakistan, Central Statistical Office, Karachi, September 1967, pp. 1603, 1614.

4/ It is not entirely appropriate to add the monthly figures together to get an annual figure because of the sharp -- but unquantified -- variation in the amount of movement.

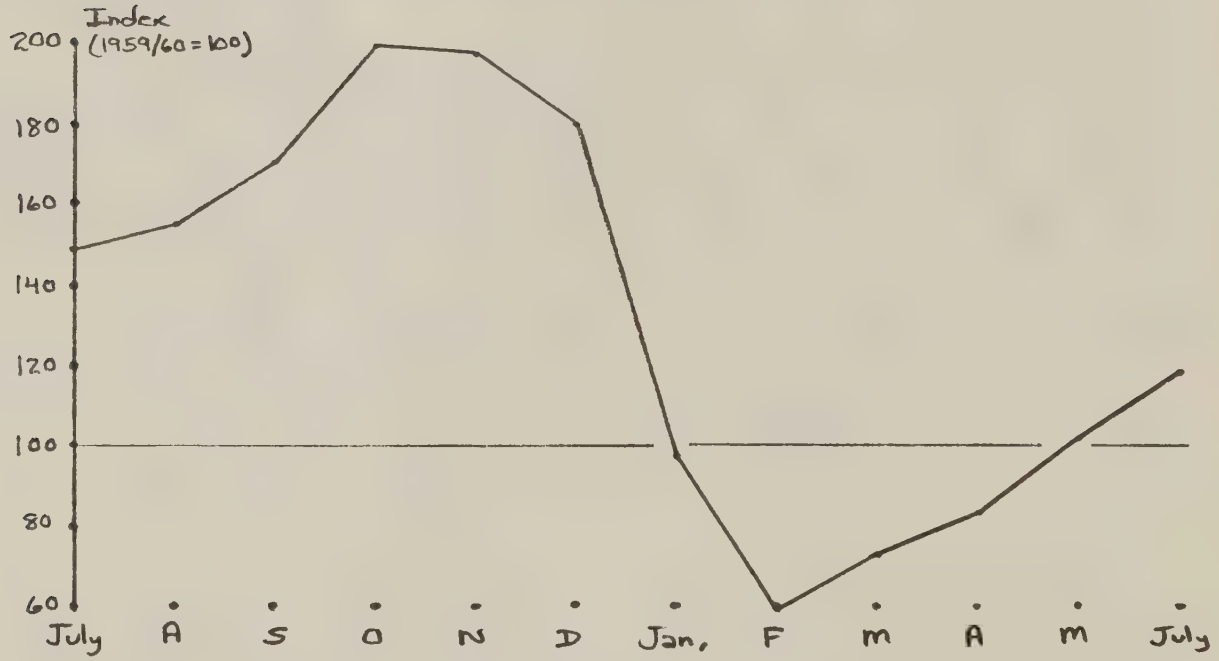
Figure 3. INDEXES OF ANNUAL WHOLESALE PRICES OF POTATOES EAST PAKISTAN, 1956/57 - 1966/67



Source: Monthly Statistical Bulletin, Central Statistical Office, Karachi

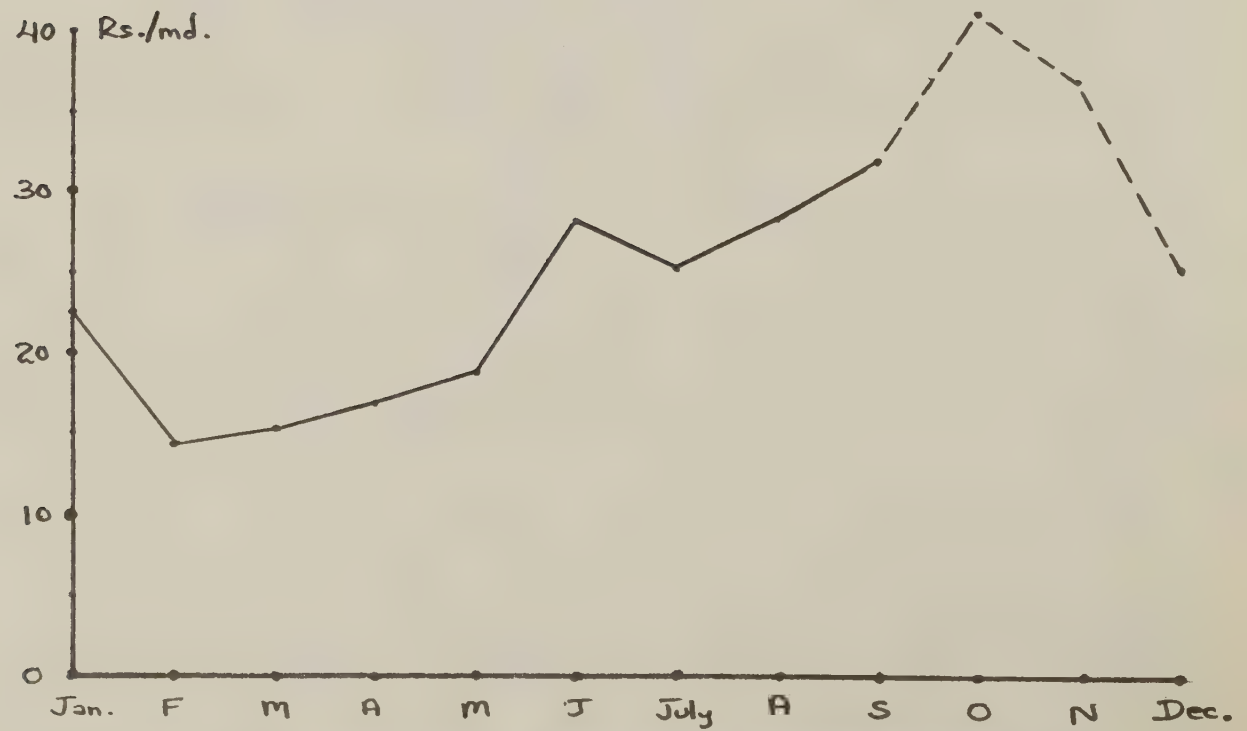
Figure 4. MONTHLY WHOLESALE PRICES OF POTATOES, EAST PAKISTAN

A. Index of Prices, 1964/65 - 1966/67



Source: Monthly Statistical Bulletin, Karachi

B. Actual Prices of Nainital, 1963-1967



Source: Directorate of Agricultural Marketing, Dacca
Note: October to December, 1963-1966 only.

d. Elasticities of Demand

In view of the incomplete data and the extremely seasonal nature of production and marketing, it would be difficult to make precise estimates of the price and income elasticities of demand for potatoes in East Pakistan.4/ However, the relatively superior status of potatoes in East Pakistan would suggest higher elasticities than are true in the United States.

Perhaps one crude way of approaching the matter of seasonal price elasticities is to draw a further analogy with the United States. In the U.S., the price elasticity of demand for later summer and fall potatoes over the 1947-60 period was quite inelastic at harvest time (in the range of -0.12 to -0.21). But with movement through the storage season, the demand became more inelastic (reaching -0.21 to -0.37 during the winter and early spring months). During the storage period, smaller but competing crops of fresh potatoes are available and these have higher harvest-time price elasticities than is true of the late summer and fall crop.5/ In East Pakistan, relatively few potatoes are stored and no fresh potatoes are available until the following season. Hence we might reason that price elasticity is also low at harvest, but not as low as in the U.S. because of "vegetable use." We might also speculate that elasticity rises less during the storage period because of lack of competing fresh potatoes.

The few recent income elasticity estimates which are available for the U.S. are very low (from 0.03 to 0.08).6/ But again, in view of the relatively "superior" status of potatoes in East Pakistan, we might assume that income elasticity would be higher -- possibly considerably higher -- especially in the urban areas.

If the previous assumptions are correct, then (1) with an increase in quantity, prices would not decrease as much as in the U.S., and (2) with an increase in income, the quantity of potatoes purchased would increase more than is true in the U.S. Derivation of empirical elasticities would

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4/ The available estimate of price elasticity (-0.2) is for all starchy roots for Pakistan as a whole over the 1960/61 - 1961/62 period (Agricultural Commodities - Projections for 1975 and 1985, FAO, Rome, 1967, Vol. II, p. 103).

5/ Olman Hee, Demand and Price Analysis for Potatoes, U.S. Department of Agriculture, Economic Research Service, Technical Bulletin No. 1380, July 1967, pp. 49, 57, 64, 69.

6/ Ibid., p. 59; Dana G. Dalrymple, "Conversion of Price Flexibilities With Respect to Income to Income Elasticities of Demand," U. S. Department of Agriculture, Federal Extension Service, Mimeo D-12, Sup., January 1965, p. 1 (based on data derived by F. V. Waugh); Robert Raunikar, J. C. Purcell, and J. E. Elrod, Consumption and Expenditure Analysis for Fruits and Vegetables in Atlanta, Georgia, University of Georgia, Agricultural Experiment Stations, Tech. Bul. N.S. 53, June 1966, p. 55.

be necessary, however, before more detailed comments could be made on the likely degree of response.

2. Costs

If data on prices are scarce, they are even more rare with respect to costs. In this brief section we shall examine what little cost information there is available.

a. Farm Level

Farm level data will be considered first in terms of total costs; seed costs will then be broken out.

- Total Costs. Several small-scale studies have been done on the cost of production of potatoes in Comilla Thana (the county around the city of Comilla).7/ We visited this area and had the impression that the area was well above the Provincial mean in levels of cultural practice. The first two studies, by Mahmoodur Rahman, covered the 1964/65 and 1965/66 seasons.8/ In 1964/65, the average cost per acre on 18 farms was nearly Rs. 900, or about Rs. 10.3/md. (at a yield of 87 md./acre). In 1965/66, when the study was expanded to cover 35 farms, production costs were only about Rs. 730 per acre, or about Rs. 8.1/md. (at a yield of 90 md./acre). Another study has recently been completed for 1966/67 by Aminul Islam on 50 farms;9/ the total cost for the farmers surveyed was about Rs. 1,030/acre or approximately Rs. 12/md. (at a yield of 85.5 md./acre). The total costs in Comilla, as indicated by these studies ranged, then, from Rs. 730 to 1,030 per acre or Rs. 8.1 to 12.1 per md.

An estimate of current costs by several government agencies would place the total cost figure at slightly over Rs. 1,080/acre, or Rs. 10.8/md. with a yield of 100 md./acre, or Rs. 12.0/md. with a yield of 90 md./acre.10/ These figures assume that modern inputs such as fertilizers and improved seeds are used.

7/ The cost of farm marketing was also included but in case it was a very minor proportion of the total -- about Rs. 0.50/md. Currently the government pays for the cost of insecticides and pesticides, but the farmer has to cover the cost of mixing agents and application.

8/ Mahmoodur Rahman, Pakistan Academy for Rural Development:
- Cost and Return, A Study of Irrigated Crops in Comilla Villages, October 1965, pp. 11-33.
- Costs and Returns, Economic of Winter Irrigated Crops in Comilla, 1965-66, March 1967, pp. 79-99.

9/ Aminul Islam, "Costs and Returns in the Production of Potatoes in Comilla Kotwali Thana in 1966/67," East Pakistan Agricultural University, Mymensingh, M.S. thesis in preparation, November 1967. (We are grateful to Dr. F. L. Underwood for bringing this project to our attention.)

10/ Unpublished estimate prepared by the Directorate of Agricultural Marketing in consultation with the Directorate of Agriculture.

All told, it would appear that costs per acre average around Rs. 1,000/acre or slightly above Rs. 10/md. if better practices are followed.

- Seed Costs. In each of the above studies, seed cost was the most important single item. The on-farm cost in the Islam and Government figures was about Rs. 40/md., or about one-third of total costs if the seeds were planted at the rate of 9 md./acre. In Rahman's 1965/66 study, the seed cost was even higher -- nearer 40% of the total. These cost figures are probably well above the Provincial average because of the heavy reliance on purchased seed in the Comilla area; Islam found that 49 out of 50 farmers bought their seed.

The exact proportion of purchased seed used on a Provincial basis is not known. We have, however, estimated that about 20% of all the seed used comes from imports and cold storage stock, which would set the upper limit. The retail cost of the imported seed was essentially fixed at Rs. 38/md. over the past two seasons (except when it was reduced to Rs. 34/md. at the end of November 1967). The cost of cold storage seed is less where imported seed is available, but varies quite widely elsewhere. We heard of estimates ranging as high as Rs. 60-70/md. in some areas.

The cost of buying home-stored seed is generally less than that for cold storage seed -- in part because it represents the unimproved as opposed to the improved type of seed. Just how the cost to the farmer of storing his own seed at home should be calculated is not certain -- but some allowance would have to be made for foregone table market price, for time spent sorting the potatoes through the storage season, for spoilage, etc.

The cost of the various farms of seed should, of course, be considered in light of their effects on output and net returns. We shall do this in Section 3.

b. Storage Level

There is no systematic information available on costs at the wholesale level. We did, however, obtain some impressions pertaining to storage charges and costs.

We have indicated earlier that the usual charge for cold storage of potatoes is Rs. 12-13/md., plus possibly a handling charge of up to 1 Rs./md. Just what the cost of operation (including capital) is to the storage operator, is not clear. The few estimates we received ranged from Rs. 6 to Rs. 9/md.

When the storage owner buys potatoes, he must also cover the cost of transportation and shrinkage. Since the potatoes are usually graded before storage, he has to pay the growers to perform the task, or do it himself. One operator indicated that he had to get around Rs. 30/md. to break even on this sort of arrangement.

3. Returns

The returns to those who grow and store potatoes in East Pakistan appear to have generally been good -- and in some cases very good.

a. Farm Level

The Comilla potato growers, whose costs were reported in the previous section, on the average have done well on potatoes. In Rahman's study, returns above all inputs averaged nearly Rs. 500/acre in 1964/65 (or Rs. 5.7/md.) and over Rs. 440/acre in 1965/66 (Rs. 4.9/md.).[11/] The farmers interviewed by Islam in 1966/67 received a net profit of slightly over Rs. 360/acre (Rs. 4.2/md.). The reported figures declined over the three-season period, but it is not known whether this represents a real situation or is a function of the different samples.

The level of returns is, of course, influenced by many factors. Among the more controllable are selections of seed and seeding rates. As we have reported earlier, the improved varieties give better yields and may bring a higher price per unit. Islam's study revealed that in Comilla an increase in the sowing rate per acre was associated with improved cultural practices and in turn with improved profits. The 25 farms which sowed at a rate of less than 7 mds./acre earned a profit of Rs. 170/acre, while the 25 farms sowing 7 mds./acre or more earned a return of about Rs. 510/acre -- a tripling of profits.

b. Storage Level

Although hard data are not available, it appears that potato storage have been a very profitable enterprise for owners. We heard estimates of rates of return from 25 to 34% -- or to put it another way, of owners paying for their plants in 3 to 4 years.

While we can't document this return,[12/] it is quite evident that there is a great deal of investor interest in cold storage. And in East Pakistan, investors evidently do not become interested in a project unless it pays more than 10%. EPSIC had some 500 applications for the 27 storages which will be built under its AID loan.

What the rate of return will be in the future can only be a matter of guesswork. But with storage capacity expected to increase four-fold within a few years, a certain decline in earnings may be expected.

11/ The comparative returns for Boro rice in Rahman's 1965/66 study were Rs. 136/acre. Returns are reportedly higher with the new varieties of rice which have subsequently been introduced.

12/ According to some calculations by EPSIC, "the return on capital can be 20% if cold storage facilities are used for potato and if if some ice is sold." Investment Brief on Cold Storage and Ice Plant, East Pakistan Small Industries Corporation, Dacca, October 1967, pp. 1, 8. (underlining added).

D. Nutritional Considerations

The purpose of increasing food production is at least to maintain and preferably improve nutrition. How do potatoes rank in terms of nutrient levels?

1. Nutrient Levels

We were not able to locate any specific information on the nutrient values of white potatoes as commonly consumed in East Pakistan. Some general data prepared under U.S. conditions however, may be of relevance. The nutrients in several forms of potatoes are summarized in Table 5 along with comparable information for rice and wheat.1/ In terms of 100 gms., fresh and boiled potatoes were equal to or greater than: (a) white rice, except for proteins and fat; (b) brown rice, except for calories, proteins, fats, and calcium. Fresh and boiled potatoes were sharply lower than wheat in all categories but the vitamins. Potato flour was higher than or comparable to rice or wheat in all categories.

2. Policy Considerations

Several studies have raised questions about the wisdom of expanding potato production from the nutritional point of view. The Nutritional Survey stated that "increased intake of this food group /starchy roots/ generally leads to decreased consumption of other more nutritious foods."2/

Another study goes on to say that the government should not encourage the production of starchy roots "... but should try to get the growers to raise substitute crops which meet the more important nutritional needs of the Province."3/

These statements would seem to raise some serious questions about the wisdom of growing potatoes. But they overlook several major points.

The first concerns relative yield per acre. In the case of Boro production in East Pakistan, potato yields were five times those of rice and ten times those of wheat during the five-year period from 1960/61 to 1964/65. The

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1/ Considerable detail on the nutritive value of potatoes may be found in: W. G. Burton, The Potato: A Survey of its History and of Factors Influencing its Yield, Nutritive Value, Quality and Storage, H. Veenman & Zonen N.V., Wageningen, 1966 (second edition), pp. 143-182; Clive M. McCay and Jeanette B. McCay, "The Nutritive Value of Potatoes," Potato Processing, (ed. by W. F. Talburt and Ora Smith), Avi, Westport 1967, pp. 218-241.

2/ Nutritional Survey, op. cit., (fn. 16, p.22), pp. 75-76.

3/ James B. Hendry and U. Hpu, "East Pakistan During the Third Five Year Plan: Estimates of Possible Performance for Selected Major Crops," unpublished manuscript, July 1964, pp. 68-69.

Table 5. NUTRITIONAL COMPOSITION OF POTATOES, RICE, AND WHEAT, Retail Weight, in 100 grams, United States

Nutrient	Unit	Potatoes			Cooked Rice		Soft Wheat
		Fresh	Boiled 2/	Flour	Brown	White 3/	Straight flour
Calories	No.	76.0	65.0	351.0	119.0	109.0	364.0
Proteins	%	2.1	1.9	8.0	2.5	2.0	9.7
Fat	%	0.1	0.1	0.8	0.6	0.1	1.0
Calcium	mg.	7.0	6.0	33.0	12.0	10.0	20.0
Iron	mg.	0.6	0.5	17.2	0.5	0.2	1.1
Vit. A	I.U.	T	T	T	0	0	0
Vit. B_1 (Thiamine)	mg.	0.10	0.09	0.42	0.09	0.02	0.08
Vit. B_2 (Riboflavin)	mg.	0.04	0.03	0.14	0.02	0.01	0.05
Niacin	mg.	1.5	1.2	3.4	1.4	0.4	1.2
Vitamin C	mg.	20.0 1/	16.0	19.0	0	0	0

Notes:

1/ Yearly average. Recently dug potatoes have 26 mg. After three months storage they have 13 mg.

2/ Pared before cooking. T = Trace

3/ Unenriched

Source: Composition of Foods, Raw, Processed, Prepared, U.S. Department of Agriculture, Agriculture Handbook No. 8, 1963, pp. 50-52, 66.

differential widened slightly during 1965/66 and narrowed a bit in 1966/67. If these ratios are applied to the nutritional values in Table 5, fresh and boiled potatoes ranked equal to or well ahead of rice and wheat in virtually every category. Thus the output per acre in terms of nutrients is generally quite favorable. In a densely populated country living close to the margin, this can be an important consideration.

A second question is whether increased consumption of potatoes "generally leads to decreased consumption of other more nutritious foods." On the basis of consumption patterns it may be questioned whether this is true except for a month or two during harvest period in the rural areas. It will be recalled that most of the year potatoes probably accounted for only a little over 1% of food consumption, and that at the peak they probably did not cover more than 10%. As we have noted earlier, potatoes are generally considered a supplement to diets, rather than a staple.

A third question is whether farmers should raise substitute crops "... which meet the more important nutritional needs of the Province." The Nutritional Survey revealed that the greatest deficiencies were in protein, fat, Vitamin A, and Riboflavin. Let's take a closer look at how potatoes rank in each category in terms of alternatives.[4/] This is a stern test for any food.

Protein. We have noted that on a 100 gm. basis, fresh and boiled potatoes rate favorably with white rice, are slightly less than brown rice, and perhaps 1/5 those of wheat.[5/] But as we have also seen, the yield of potatoes has run about five times that of rice and ten times that of wheat during the Boro season in East Pakistan. Thus, nutrient output per acre is higher for potatoes. The biological value of the protein in potatoes is slightly less than in rice, but above that in wheat flour.[6/]

There are other crops such as pulses, certain vegetables, and nuts which have higher protein levels than potatoes. But before evaluating them as possible substitutes, one would have to examine how they would compare in yield and in adaptability to present production, marketing, and consumption patterns. Low prices for pulses, for instance, have led to a

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4/ These comparisons assume that the relative nutrient values cited in Table 5, which are based on U.S. conditions, also prevail in East Pakistan. Empirical study is needed on this point.

5/ There is some reason for believing that the new high-yielding varieties rice and wheat may be producing grain of a lower protein level. This matter is being examined by Dr. Aaron Altschul of the International Agricultural Development Service, USDA, and the International Rice Research Institute.

6/ Protein: At the Heart of the World Food Problem, FAO, World Food Problems No. 5, 1964, p. 12.

decline in production over the past decade.[7] One alternative might be to fortify grain supplies.

Fat. In terms of 100 gms. of product, potatoes by themselves rank low in fat compared to rice and wheat.[8] The situation is evened out when yields per acre are considered. Even so, none of the three ranks particularly high in fats.[9] Significantly higher levels of fat could probably be obtained from such crops as tree nuts, groundnuts (peanuts), and oilseeds. But as with protein, production and consumption considerations would have to be examined.

Vitamin A. Potatoes have negligible values of this nutrient. Grains are in the same category. Traditional sources are yellow pigmented foods such as corn, carrots, and yellow sweet potatoes. While sweet potatoes are raised in East Pakistan, they are of the white type, which has a very low Vitamin A level: yellow varieties would be needed. Carrots might be a good possible source; they could also be kept for long periods in refrigerated potato storages. Both crops might well be considered further if Vitamin A is to be given high priority.

Riboflavin. Fresh and boiled potatoes appear to rank better in this nutrient than rice and wheat on a 100 gm. basis, and would rate considerably higher in terms of nutrient production per acre. Certain leafy vegetables might rank better on a 100 gm. basis, but less well on a yield basis. The matter would have to be examined further. However, the present state of the marketing system would hinder the production of the more perishable vegetables.

3. Implications

The fact that potatoes have a high nutrient production per acre could be important in a country where undernourishment exists or is not far away. It is less important in a country which has sufficient food to avoid this problem, but does not necessarily have the right balance of nutrients -- where malnutrition exists. The latter seems to be more generally the case in East Pakistan at present.

The Nutritional Survey revealed that the greatest nutrient needs in East Pakistan are for proteins, fats, Vitamin A, and riboflavin. The problem,

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7/ Daniel G. Ritchie, "Agricultural Requirements for East Pakistan, 1985," enclosure to Department of State Airgram, Dacca, No. A-186, December 28, 1967, pp. 6, 12. (Unclassified)

8/ An exception is provided in the U.S. by the various forms of fried potatoes, which rank relatively high in fat.

9/ While we were in Dacca, the comment was made several times that even though consumers would fill up on rice, they would still feel hungry. This may well be related to low fat levels. As Norman Derosier states, man"... requires fat to give his diets satiety value, that full, satisfied feeling which comes only from fat in good food" (Attack on Starvation, Avi, Westport, 1961, p. 14).

then, is to increase the amount or quality of these nutrients in a given quantity of food. While fresh and boiled potatoes may not be the best vehicle for this, neither are the grains -- though wheat flour does rank well above rice and potatoes in this respect. Young children, who are particularly apt to suffer from protein deficiency, simply cannot consume enough grains to get sufficient protein.

The answer will have to be found in other ways. Other known crops are higher in both proteins and fats, or Vitamin A and B_2. But no one crop rates high in all. Furthermore, it is not clear how the other crops would fit in with existing production, marketing, and consumption patterns. To be economically viable alternatives, they would have to be profitable for the farmer, suitable to the marketing system, and acceptable by the consumer. Possibly the answer is not in other crops but in practices such as fortification. Determination of these matters would take considerable study.

Potatoes may not be nutritionally perfect, but they strike about as good an overall balance as any individual commercial crop can in East Pakistan at the present. As conditions change it may be possible to develop supplementary crops or techniques to better meet shortages of specific nutrients.

III. SEED POTATO IMPROVEMENT

Seed potatoes play a key role in the improvement of the potato industry in East Pakistan. In this section we will first outline the present situation, and then review the improvement program proposed by the Agricultural Development Corporation (ADC) in terms of assumptions, pros and cons, and alternatives. Finally, we shall offer some thoughts on storage location and present some suggestions for implementation.

A. Present Situation

Seed potatoes are presently available in East Pakistan through one of three sources. The traditional source is farm storage. A newer method is the cold storage of improved varieties. The third is the import of a limited quantity of certified seed from Holland.[1/] The structure of these sources is outlined in Figure 5.

1. Traditional Sources of Seed

The predominant source of seed in East Pakistan has long been home production and storage. As we indicated in earlier sections, perhaps 80% of the seed has come from this channel in recent years. The home-stored varieties are essentially all unimproved native stock. The quantity of seed available is determined by the previous season's production, the demands of the farm family for food, and storage conditions.

Home storage can be an expensive process due to (a) physical losses caused by spoilage, rats, etc. and (b) physiological deterioration which reduces seed quality. Home storage losses, however are not an out-of-pocket cost; furthermore, at the time of planting, precious cash resources are not needed to buy seed. It may, of course, be cheaper over the long run to buy more productive cold storage or imported seed, but many farmers may not be able to afford the initial investment.

2. Cold Storage Seed[2/]

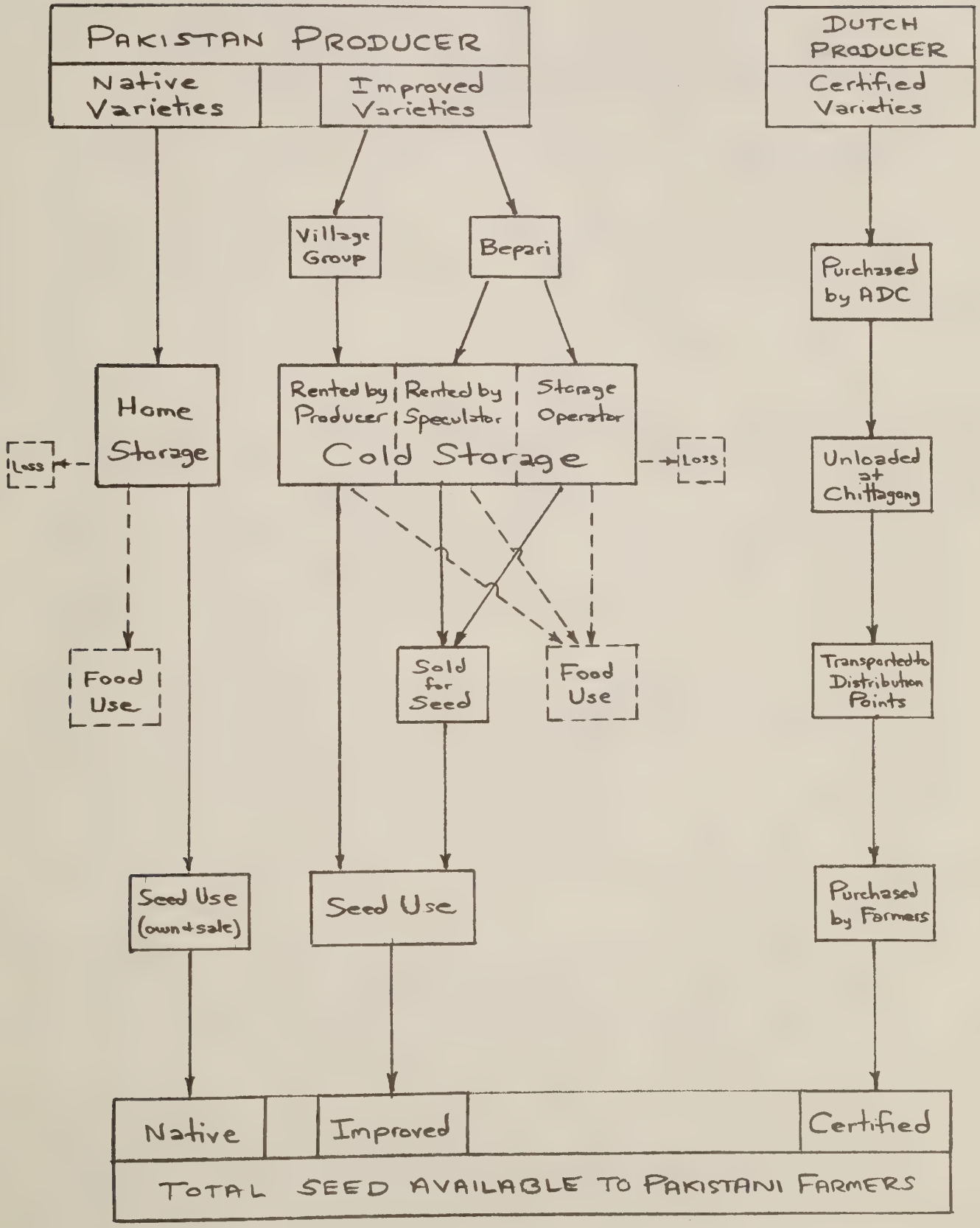
A small but increasing quantity of seed is being held in refrigerated cold storage. It is difficult to determine the precise quantity, but it probably represents between 10 and 15% of the total seed supply.

Generally, virtually all of the potatoes stored are "improved" varieties; that is, they are the second, third or later generations of imported seed. These varieties do not keep at all well in home storage.

1/ The imported seed is considered here as "first-generation" seed. After it the initial planting in East Pakistan, the seed produced is considered "second generation"; after the second planting, "third generation," etc.

2/ An exception to the general pattern described in this and the following section is provided by the cooperative at Comilla which has a modest seed improvement program centered about the storage.

Figure 5. GENERAL STRUCTURE OF SEED POTATO DISTRIBUTION IN EAST PAKISTAN, 1967



There are several institutional avenues open for cold storage holdings. Individual farmers or groups of farmers may rent storage space for seed. Or they may sell undesignated but graded potatoes to (a) speculators, who rent storage space, or (b) to cold storage operators. The speculators or operators may then determine the allocation between table and seed stock on the basis of price, quality permitting. Normally they prefer to sell the potatoes for seed because it brings a higher price (though it may be indistinguishable from table stock). But a high table price during the season will reverse the situation. Thus the amount and price of cold storage stock which is available for seed can be quite variable. The farmer counting on a precise quantity at a certain price level may be better off making his own storage arrangements.

Reflecting both the "improved" nature of the variety and storage conditions, cold storage seed is usually superior to home-stored seed, but a step below imported seed. The exact placement depends on the generation and the amount of disease.

3. Imports of Improved Seed

East Pakistan has, for many years, realized the need for improved potato seed. Like many nations it has imported a portion of the seed needed. This has been done through the Agricultural Development Corporation.3/ The quantities purchased and the amounts expended in foreign exchange cost in recent years are listed in Table 6.4/ The quantity purchased is reportedly based on needs reported by District Agricultural Officers, adjusted in light of foreign exchange allocations (the latter is probably the key factor). In American terms, East Pakistan in 1967/68 imported about 3,360 short tons of seed potatoes for which it paid $416,000, or about $124/ton.

While sizeable amounts have been spent for the imported seeds, they only provide a fraction -- generally 5 to 6% -- of the total quantity of seed which has been used. The remainder is second or third generation imported seeds from cold storage, or local varieties. Though the proportion of imported seed is small, foreign exchange difficulties have led to strong pressure to reduce the amount expended.

For many years, the seed potatoes came from India and Burma. Due to the disputes with India, their portion of the imports was transferred to

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3/ One of ADC's main functions has been the improvement of seeds for a wide line of crops. For general background material see: George M. Platt, "Agriculture: Administration and the Search for Expanded Productivity," Administrative Problems in Pakistan (ed. by G. S. Birkhead), Syracuse University Press, 1966, pp. 101-102.

4/ According to the ADC, all of East Pakistan's potato imports are utilized for seed. Details on the value of potato imports may also be obtained from a publication of the Central Statistical Office in Karachi, Monthly Foreign Trade Statistics of Pakistan. During the 1966/67 season, the two sets of totals were within 1.5% of each other.

Table 6. QUANTITY AND COST OF IMPORTED SEED POTATOES EAST PAKISTAN, 1959/60 - 1967/68

Season	Quantity (maunds)	Cost (rupees)	Cost per Unit (rupees/maund)
1959/60	80,000	NA	NA
1960/61	120,000	NA	NA
1961/62	72,000	NA	NA
1962/63	178,631	4,047,000	22.6
1963/64	34,842	766,000	21.9
1964/65	92,343	2,066,450	22.4
1965/66	71,529	1,632,141	22.8
1966/67	54,500	1,255,878	23.0
1967/68	81,750	1,980,898	24.2

Notes: 100 maunds = 8,229 lbs. = 3.674 long tons = 4.115 short tons

100 rupees = $21.00

Source: East Pakistan Agricultural Development Corporation

Holland in 1964/65. Due to internal problems, Burma went out of the supply picture in 1966/67. This left Holland as the sole source.

There were advantages and disadvantages in switching seed imports entirely to Holland. The main advantage was and is that all the seed is certified: it is of high quality and is at least 99% disease free.5/ The main disadvantage was and is distance: it takes time to ship the potatoes to East Pakistan. In 1966/67 the potatoes arrived quite late, but fortunately the season was late. Due to a change in purchasing procedures for the 1967/68 season, the seed was shipped much earlier, but the closing of the Suez canal necessitated a long trip around Africa. Still, the seed arrived earlier -- but then, alas, the season was earlier.

In part as a result of the late arrivals from Holland, the distribution of seeds has been limited to the central and southern districts of East Pakistan. With the poor transportation facilities, there hasn't been time for widespread distribution. During the 1967/68 season, 75% of the seed went to two districts, Dacca and Comilla, which in turn accounted for only 19.5% of the potato acreage. Or to put it differently, the imported seed potatoes provided 30% of the seed "requirement" for Dacca and 11% of Comilla's "requirement."6/ On the other hand, the four important districts in the northwest -- Dinajpur, Rajshahi, Bogra, and Rangpur -- which represented 44% of the potato area, received no imported seed. The important north-central area of Mymensingh received only a trace.7/ Other districts obtained small amounts. In the past, potatoes have been distributed within the districts on the basis of lists drawn up by the District Agricultural Officers and Union Council Chairmen.

For the farmers who were able to buy seed, the official price from 1962/63 to 1963/64 was Rs. 36/md; thereafter it was Rs. 38/md. (in some remote areas it may have been slightly higher). A breakdown of the 1967/68 price of Rs. 38/md. reveals that: the C.I.F. (cargo, insurance, and freight) cost was nearly Rs. 25/md., or about 65% of the retail price; the distribution cost was Rs. 6.5/md., or slightly over 17%;8/ Taxes, unloading and

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5/ India and Burma had no formal seed certification programs and were reportedly chary of letting Pakistan authorities investigate the growing areas.

6/ The "requirement" was calculated on the basis of 1966/67 acreage seeded at the rate of 9 maunds per acre.

7/ It may be of interest to recall that average yields in these five districts were the lowest in East Pakistan in 1966/67 (Table 2). An exception was provided by Rangpur, but it had unusually high yields in 1966/67; yields in previous years were on a par with the other four districts.

8/ The distribution cost included: transportation from the port to the point of distribution, Rs. 2.50/md.; shrinkage and spoilage, Rs. 1.00/md.; and distributor's profit, Rs. 3.00/md. In 1967 about half of the distribution was done by ADC, and half by commercial firms.

handling charges, and overhead took the remaining Rs. 6.5/md, or 17%.[9/]

An unexpected sales problem arose with the Holland seed during late 1967. Whereas in previous years demand for the seed had been greater than supply, a reverse situation began to appear in mid-November. Movement slowed and there was concern with unsold stocks. As a result, the price was dropped to Rs. 34/md. on November 25. Why did demand drop off? The answer is not entirely clear, but the following factors may have been involved: (1) the total supply was 50% greater than in the previous season, yet the distribution area was no wider; (2) the season was early and consequently many potatoes had been planted and new potatoes were reaching the market when the Holland stock arrived; (3) the prices of cold storage potatoes were lower than in previous years[10/]; (4) some of the second generation Holland potatoes -- those held in cold storage -- developed hollow heart; and (5) some growers were attracted to rice rather than potatoe production because of the new high-yield varieties, and high rice prices. It was a peculiarly unfortunate twist of fate that all of these factors occurred simultaneously. ADC officials felt that interest in the Holland seed would be stimulated by demonstrations showing the beneficial effect of the new varieties on production, and by greater availability of credit.

9/ The specific breakdown was: taxes, Rs. 2.10/md.; clearing and handling charges, Rs. 1.00/md.; ADC administrative charge, Rs. 2.50/md.

10/ It is hard to determine the precise reason for this. It could be a combination of the other factors listed here. At one point we were told that it was because the storage operators didn't know that ADC was going to import seed stock, but this seems rather weak because seeds have been imported every year in the recent past.

B. Proposed Program

The Agricultural Development Corporation of East Pakistan has proposed a multiplication program which would both cut down on the foreign exchange requirements of seed and increase the quantity of seed available.[1/] Under the proposal, the imported seed would be solely used for the production of seed stock -- which would then be placed in storage and sold the following season. The present and proposed systems are presented in diagrammatic form in Figure 6. The program would be, as far as we know, unique.

1. The Major Features

Under the proposed program, yearly imports of seed would -- after the first year of operation[2/] -- initially be cut back from present levels (81,000 maunds in 1967/68) to 20,000 maunds. However, these potatoes would be used exclusively for the production of seed stock -- not for all purposes as is now the case. The seed potatoes would be raised in five major potato districts, three of which are in the presently neglected areas (in terms of improved seed) of Bogra, Rajshahi, and Rangpur; the other two would be in Dacca and Comilla. The potatoes would be grown by carefully selected farmers in isolated areas not presently used for potatoes. The farmers would be given technical advice and instructions from ADC, and would agree to sell all of their certified grade potatoes to ADC. To encourage production, and to cover extra costs, a premium will be paid at harvest time for the potatoes of certified grade. The farmers will be free to sell the others as he wishes.

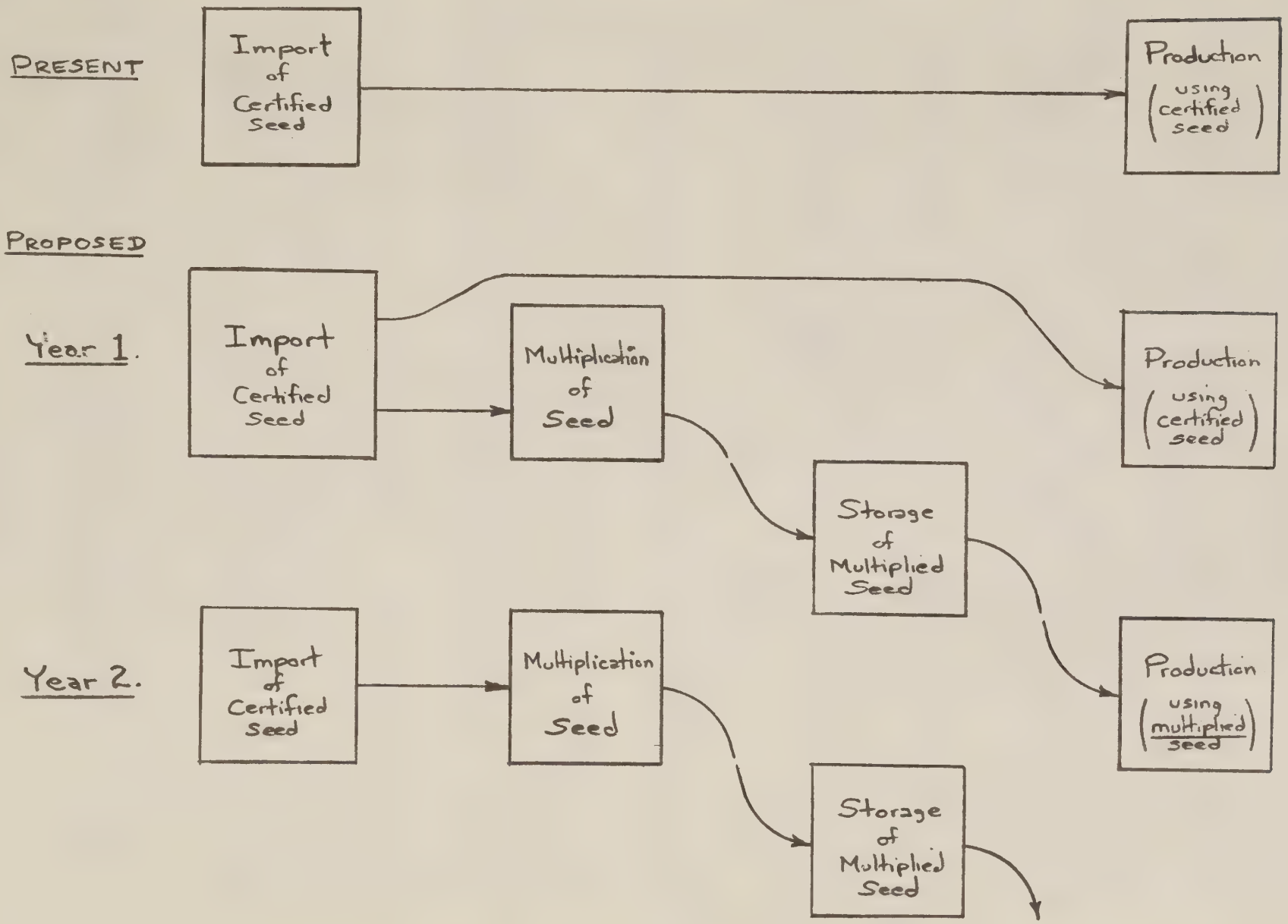
The multiplied potatoes would be placed in specifically designed cold storages -- described in the Bovay report -- in each of the five areas. Tentative locations are Rangpur (city), Shantahar, Rajshahi (city), Mushiganj, and Chandpur (see map on p. iii).[3/] ADC will own and run the storages, each of which will have a capacity of 1,000 tons. The second-generation seed placed in storage will then be sold at planting time to to regular farmers in the district or region.

1/ The proposal was originally outlined in "Scheme for Multiplication, Preservation and Distribution of Improved Seed Potato," April 1967. 20 pp. By November 1967, minor modifications had been made in the proposal which are reflected here.

2/ The first year would be an exception in that some imports would presumably be continued for direct use by regular farmers (see Figure 6).

3/ The matter of storage location is discussed in greater detail in Section E (pp. 61-63). Following our visit, the tentative location of the Dacca District storage was moved from Mushiganj to Kessempur, north of Dacca City.

Figure 6. FLOW OF IMPORTED SEED POTATOES UNDER PRESENT AND PROPOSED SYSTEMS, EAST PAKISTAN



It is projected that the 20,000 maunds imported each year would plant a total of 2,000 acres, in turn producing 150,000 maunds (or 5,500 tons) of acceptable seed. In making these calculations it is assumed that (1) there would be a 10% loss between receiving and planting, (2) that the planting rate would be 9 mds./acre, (3) that the yield would be 100 mds./acre, and (4) that 75% of the production would be acceptable.

The proposal envisages selling the imported stock to seed growers at Rs. 40/md. The multiplied seed potatoes will be purchased at a premium of Rs. 3/md. above going market prices at harvest-time. The average price is calculated at Rs. 15/md., meaning that the purchase price would be Rs. 18/md. ADC would then transport the potatoes to storage and sell them at planting time the following season at Rs. 40/md.

In each area, working out of each storage, would be one horticultural supervisor and two assistants.[4/] Over each of the supervisors would be one centrally-placed and highly-trained potato specialist. This group would supervise the horticultural aspects of the project - advising farmers when and how to spray and fertilize, what plants to rogue out, etc. The foreign exchange cost of the capital investment in machinery would be met by a low interest loan from AID. Other capital costs would be met by local financing.

2. The Major Assumptions

What are the major assumptions which have been made in drawing up these plans? How do they stand up in view of our observations?

a. Production of Multiplied Seed Potatoes

The proposal envisages, as noted, that 20,000 mds. of imported seed will be multiplied into 150,000 mds. of second-generation seed for general planting -- a 7.5 fold increase. For each of the five areas this would call for the import of 4,000 mds. and the generation of 30,000 mds. Does this appear reasonable?

To help provide an answer, we have run through the ADC assumptions on the basis of one of the five areas, and then have followed them with alternate assumptions. These are presented in Table 7. We think it is likely that the yields will be higher than 100 mds./acre assumed by ADC but that the acceptance rate will run lower than 75 percent, at least in the first few years. Even so, two combinations of alternatives -- and admittedly many others could have been tried -- suggest that production of 30,000 mds. of seed is feasible. It may not, however, come right away.

4/ We assume that the field personnel will work in the storage following harvest - but this point is not explicitly states. The storage season duties of the horticulturalist will be discussed on p. 68.

Table 7. PROSPECTIVE PRODUCTION OF MULTIPLIED SEED POTATOES, EAST PAKISTAN

	ADC Assumptions	Our Alternatives A	Our Alternatives B
1. Purchases from abroad	4,000 mds.	4,000 mds.	4,000 mds.
- loss in transport and distribution	(10 %)	(4 %)	(8 %)
2. Sold for multiplication		3,840	3,680
- loss between purchasing and planting		(2 %)	(2 %)
3. Quantity planted	3,600 mds.	3,763	3,606
÷ seeding rate	(9 mds./acre)	(9 mds./acre)	(9 mds./acre)
4. Area planted	400 acres	418	401
x yield	(100 mds./acre)	(120 mds./acre)	(140 mds./acre)
5. Production	40,000 mds.	50,160	56,140
÷ proportion acceptable for seed	(75 %)	(66.7 %)	(60 %)
6. Quantity of acceptable seed	30,000 mds.	33,457	33,684
- loss between farm and storage	(-)	(2 %)	(2 %)
7. Quantity placed in storage		32,788	33,010
- loss in storage	(2½%)	(5 %)	(5 %)
8. Available for sale as seed	29,250 mds.	31,149 mds.	31,360 mds.

b. Financial Return to ADC[5/]

The potential gross income to ADC from the multiplication program can be rather easily calculated. If, in the case of one of the five storages, about 3,600 mds. of imported seed were actually sold at Rs. 40/md., the return would be Rs. 144,000. The sale of 29,250 mds. of multiplied seed at Rs. 40/md. would return Rs. 1,170,000. The total for the cycle would be Rs. 1,314,000.

The previous section has suggested that the quantities involved are probably reasonable after an adjustment period. Considering the price break in November 1967, however, a price of Rs. 40/md. may be on the high side. We don't know. But perhaps it would be more conservative to use a price of Rs. 38/md., which would reduce the gross for the cycle to Rs. 1,276,800. This reduction would mean that the differential between purchase and sale price of the multiplied seed would be reduced from Rs. 22/md. to Rs. 20/md. - a drop of 9%.

The assessment of actual costs and net returns is a rather complex process, involving use of engineering cost estimates,[5/] and will be presented in detail in a subsequent chapter (V., pp. 75-8). Suffice it to say here that the project appears economically feasible.[6/]

c. Financial Returns to Growers

It would seem that the potential returns to growers should be sufficiently attractive to induce them into the multiplication program. They will be the only growers in the country to get imported seed. They will be provided with technical assistance. Yields, as a result, should be quite good. A guaranteed market will be available for the majority of production at a premium of Rs. 3/md. above the going market rate.[7/] The rest of the potatoes, representing the best stock in the country, should sell at favorable prices. One of the factors limiting the use of improved seeds at present -- credit to buy the stock -- will be provided by ADC.

The other side of the coin, of course, is that growers will have to give much more attention to cultural practices than is customary. Some may underestimate the number of sprays, the number of plants that will have

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5/ The financial report takes into account data obtained from the engineering study -- information which did not become available until April 1967.

6/ In the ADC project statement (fn. 1, p.44) it was projected that the following costs would be covered by the government as a grant: EPADC overhead, the horticultural advisory staff at the storages, and the premium of Rs. 3/md. paid for multiplied seed.

7/ This rate has been used by the cooperative at Comilla and has proved satisfactory.

to be rogued out, etc. Since the areas to be selected for multiplication are to be somewhat isolated from the main production areas, many growers will have to be induced into potato production.

A rough attempt at estimating possible average returns to growers is provided in Table 8. Assumptions of yields and proportion acceptable are the same as those used in Table 7. The estimates of prices paid for seed stock are in line with our discussion in the previous section. The estimates of prices paid for other uses is purely arbitrary. The assumption for total expenditures is derived as follows: (1) the ADC figure is based on the average cost of Rs. 1,080/acre reported by several government agencies (page 30); (2) the figure used in our alternatives is based on an estimated production cost of Rs. 1,000/acre with improved practices (page 31), adjusted upward by arbitrary estimates of Rs. 200/acre and Rs. 300/acre for the additional requirements of seed production (roguing, special attention to insect and disease control, etc.).

Estimated net receipts show a wide range -- from a possible low of Rs. 450/acre under the ADC assumptions to perhaps Rs. 700/acre under one of our variants. We noted earlier (page 32) that recent returns for potato production in Comilla Thana averaged Rs. 400 - 500/acre. Under ADC assumptions, participation in the multiplication program might be in the same range. Under our assumptions, returns would be more attractive; while an average of Rs. 700/acre might be high, a figure of Rs. 600/acre might not be far from reality after the first year or two.

Obviously these estimates are subject to a wide range of error. Many alternative estimates could have been selected. But all the same, they seem to provide further support for the hypothesis that production of multiplied stock is likely to be profitable to the farmer in the longer run. The profit situation might be less favorable during the probable trials and tribulations of the first year or two.

Table 8. PROSPECTIVE FARM RETURNS FOR MULTIPLICATION OF SEED POTATOES, EAST PAKISTAN

		ADC "Assumptions"	Our Alternatives A	Our Alternatives B
1.	Average yield	100 mds./acre	120 mds./acre	140 mds./acre
2.	Proportion:			
	- Acceptable by ADC	75%	66.7%	60%
	- Salable elsewhere	20	28.3	35
	- Waste, loss, etc.	5	5.0	5
3.	Quantity acceptable for ADC	75 mds./acre	80 mds./acre	84 mds./acre
	x Price paid by ADC	(Rs. 18/md.)	(Rs. 18/md.)	(Rs. 18/md.)
	Receipt from sale to ADC	Rs. 1,350/acre	Rs. 1,440/acre	Rs. 1,512/acre
4.	Other salable potatoes	20 mds.	34 mds.	49 mds.
	x Price received	(Rs. 10/md.)	(Rs. 10/md.)	(Rs. 10/md.)
	Receipt from other sales	Rs. 200	Rs. 340	Rs. 490
5.	Total net receipts	Rs. 1,550	Rs. 1,780	Rs. 2,000
	- Total Expenditures	(Rs. 1,100)	(Rs. 1,200)	(Rs. 1,300)
6.	Net receipts	Rs. 450/acre	Rs. 580/acre	Rs. 700/acre

Note: The ADC "assumptions" refer only to yield, proportion acceptable by ADC, and average ADC price; the other data have been arbitrarily selected.

C. Pros and Cons of Proposed Program

Given the nature of the proposed seed program, what are the major potential benefits of the multiplication program, as well as the more important potential constraints?

1. Benefits of Program

The proposed multiplication and storage program holds promise of many benefits. They may be divided into primary and secondary classifications. Each will accrue to different groups in different degrees.

a. Primary and Direct Benefits

The first order of benefits is most apt to flow directly from the project -- and they are probably most responsible for its proposal.

One of the most important benefits from the viewpoint of several government agencies is that the program should make it possible to substantially reduce foreign exchange costs. In terms of 1967 imports, and those envisaged, the cut would be about 75% (from slightly over $400,000 to perhaps $100,000 in current costs). There is evidently now considerable uncertainty from year to year as to the availability of foreign exchange; under the proposed program a lower but much more stable level will be set.

Of more direct value to agriculture will be an increase in the amount of seed over what has been available during the last five years -- or more to the point, what is likely to be available if the present system were continued or reduced. Again taking this year's level as a base, there would be an increase of nearly 90%, from 80,000 to 150,000 mds. The extra quantity, and the fact that it will be held in local cold storage, will mean that it will be possible to make improved seed available, for the first time in several years, to the important potato producing districts in the northwest. At the same time, the same total amount of improved seed should be available in the two major districts which are now receiving it.1/

The timing factor will be of widespread importance. Over the last two years, the imported seed has arrived too late for many farmers. The domestically multiplied seed will be available as soon as desired. Moreover, the farmers will be able to count on it in advance. The reduction of uncertainty about the amount and timing of supplies should provide a boost for the use of seed. In addition, the presence of refrigerated storage will mean that the pressure to sell the multiplied seed stock within a particular brief period will be lessened.2/

1/ The fate of other small districts is not clear at this point but it might be possible to ship them some of the storage stock.

2/ As it is now, the imported seed potatoes are not refrigerated by the distributors -- in fact some we saw were held outside in an open pen. With the warm temperatures that prevail in East Pakistan, this means that the potatoes can deteriorate fairly quickly.

b. Secondary Benefits: Social and Economic

Increased use of improved seed should lead to a number of social and economic benefits.

First, the expanded quantity of improved seeds should directly lead to increased Provincial production. But because of the relatively small size of the seed program, the overall effect will be modest. If it is assumed that the proportion of acreage planted to improved seed expanded from 5% to 10%, the increase in total Provincial production might be about 2%.3/ If the existing program were cut back, as could happen, to say half or a third of current levels, the increase attributable to the proposed would be around 4%. With the increase in quantity of improved seed under the new program, there would be a corresponding increase in the quantity of subsequent generations of "improved" seed stock4/ (while yields of residual generations fall off quickly, those of the first few are still above those of unimproved native varieties).

Secondly, farmers using the multiplied seeds should receive improved income. The effect could occur in three ways, each of differing certainty and importance. (1) The ADC program may mean lower-cost seeds, particularly in the northwest districts. (2) The improved seeds will -- with proper cultural practices -- lead to significantly greater production at a modest increase in cost. (3) The improved varieties may sell at a slightly higher price than unimproved varieties (they have, as noted on p. 25, in the past5/).

Thirdly, the improved varieties are those most suited to cold storage; the benefits to native varieties are more marginal. With an increasing quantity of cold storage going up, there will be an expanded opportunity to store the improved varieties. There might also be an increased demand for the improved varieties from those who own storages and need to fill them up. Increased storage of improved varieties will help even out the present sharp seasonal variations in supply and should help reduce price fluctuations.

3/ This estimate is based on 1966/67 figures and assumes that the additional seed is planted in the place of native varieties. If it replaced storage seed the increase could be less. If it represented new planting the increase would be greater. (Specific yield assumptions were: native seed, 3.3 tons/acre; imported seed, 5.28 tons/acre; multiplied seed 5.0 tons/acre.)

4/ In recent years, some 10 to 15% of the total seed supply -- the amount held in cold storage -- probably fell into this category.

5/ If increased profitability leads to increased utilization of land that otherwise would remain idle, there will be a further increase in net food supply.

c. Secondary Benefits: Other Seed

The operation of a well regulated and controlled seed program should have positive multiplier effects on other seed potatoes. At present the situation for other stock is rather chaotic. Quality of seed varies greatly. Prices often fluctuate wildly - and in some cases are extremely high. The farmer generally has little knowledge of the quality of the stock he is buying and even less influence over the price he has to pay.

The fact that quality potatoes are available at standardized prices from the ADC storage should help stabilize the quality of seed potatoes grown and stored. High technical standards of operation for the ADC storages should provide a good example for others. The presence of good seed at standardized and reasonable prices should reduce the more extreme price fluctuations.6/

This is not to say that the process will be a graceful or harmonious one. It may be tough on both sides. The ADC storages may find themselves faced with competition from what they consider inferior potatoes at lower prices. On the other hand, the private storages may in some way look upon the ADC storages as unfair competition.7/ But in the final analysis, we think that the result will be generally improved levels of seed quality at more moderate prices. This in turn would lead to greater interest in using improved seed.

To put it another way, the ADC program could have very substantial indirect benefits through the informal "policing" effects it might have on the quality and prices of other potatoes. These effects alone might merit its implementation.

On balance, the array of potential benefits -- both direct and indirect -- is quite impressive. How do they compare with possible constraints?

2. Constraints on Program

Effective operation of the proposed multiplication and storage program will clearly be more complex than the existing program.8/ It will require close regulation of production and storage, particularly in the first few years. The farm production end is apt to be the most difficult problem. As a Dutch potato specialist recently put it: "improving the ... storage

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6/ The ADC standards could particularly help set the tone for a seed quality program which is being given preliminary consideration for the EPSIC storages.

7/ There is a feeling on the part of some that the presence of the Holland potatoes at fixed prices has helped keep the prices of cold storages stock within reason.

8/ For discussions of the factors involved in grain seed multiplication, see: Richard F. Holland, "Inputs for Seed," The World Food Problem, The White House, Vol. III, September 1967, pp. 118-130; "Seeds," The World Food Problem, Vol. II, May 1967, pp. 387-391.

facilities in Pakistan is a much easier task than establishing a national supply of seed potatoes."9/

a. Import and Multiplication of Stock

It will be necessary for the imported seed to arrive early enough each season to allow distribution to the important potato areas in the northwest. This has not been accomplished in the past and will be difficult to do with Holland seed until the Suez Canal is opened. Assuming the imported seed does arrive on time, there could be a problem with short-term refrigerated storage: unless enough of the multiplied stock has moved out, there might not be sufficient capacity to provide short-term storage for the imported stock.10/

A related problem concerns varieties. The present Dutch varieties are not universally desired. In Comilla Thana, for instance, there appears to be a definite farmer and consumer preference for the Burma variety. The Holland varieties in this and some other areas tend to form hollow heart in cold storage.11/ The Dutch are aware of these matters and are working on them.12/ Still, varieties from other countries should be tested.

Part of the variety problem is that the present level of technical knowledge about potato production is very low. Little good research is available. Few administrative or extension workers are well versed in improved practices. Farmers are by and large wedded to traditional practices. Improved technical knowledge is essential.

It would be easiest to put improved knowledge and techniques to good use if it were possible to concentrate production on a few large and carefully controlled government or private farms. Breaking multiplication up among hundreds of small farmers whose holdings are in turn divided, will make insect and disease control more difficult and will likely result in a lower and less uniform quality seed. But large farms or areas are evidently not available.

9/ Winkel, op. cit. (see fn. 9, p.10), p. 6.

10/ This presumes that the imported seeds would be sold to seed growers at the ADC storages.

11/ This could be avoided by more frequent irrigation. We don't know how difficult it would be to change current practices in this respect.

12/ At the time of our visit, two members of the Dutch Information Centre for Potatoes were in Pakistan. One was to stay for several months to do variety testing.

Because of the fractionated nature of production, and other reasons, the volume of production of seed potatoes of acceptable quality may be less than desired the first season or two.13/ If so, it may be necessary to import additional seed potatoes for use by regular farmers the following years. But even if the national supply of seed reaches desired levels, it is doubtful that the quantity produced in each of the five areas will exactly match storage capacity in that area. There will be local under- and over-supply. Some method of adjusting those imbalances will be needed.

b. Farmer Use of Multiplied Stock

Under the proposed program, growers who have been using Holland seed will no longer be able to get it, unless they join as producers of improved seed. Hence, growers of table potatoes will have to switch to second-generation cold storage seed which, even if everything goes well, will likely not produce as much as the first generation imported stock. This may lead to some disenchantment.

In some areas in the southeastern portions of the country, the new IRRI rice varieties may provide increasing competition with potatoes for land during the Boro season. The new varieties have made it more profitable to raise rice where adequate water is available. Competition with rice is evidently considerably less in the dryer sections in the northwest. Still, production alternatives need to be considered.

The five ADC seed potato storages may face price competition from regular cold storage seed potatoes. This year it was necessary to reduce prices on Holland stock from Rs. 38/md. to Rs. 34/md. in order to move it; under the proposed program the price is to be Rs. 40/md. A sharp increase in storage capacity is expected, which would provide the basis for further competition. (There is a wide geographic variation, however, with the least construction scheduled for the important potato producing area in the N.W.)

Finally, and somewhat aside from the previous points, if the program is successful, there will be a demand to enlarge it. This would require increasing imports of certified seed and storage machinery from abroad. Both will require added foreign exchange.

13/ Although the seed farmers will agree to initially supply all their output to ADC, it is not inconceivable that some might decide not to do this. We are not sure to what degree pressure can be brought on them, but in any case they could be dropped from the program the following year.

14/ Variations in weather alone could cause substantial fluctuations in supplies.

D. Review of Alternatives

In evaluating the program proposed by ADC, it may be helpful to consider some of the major alternatives. Three of the major ones relate to (1) type of program, (2) source of seed stock, and (3) the question of public or private operation.

1. Types of Programs

The ADC program is, of course, not the only one that could be followed. How do the alternatives look?

One extreme alternative -- which would certainly solve the foreign exchange problem in the short run -- would be to cut out imports altogether. The difficulties with this action should be obvious by now: the quality of seed would run down even more, yields would drop, and total output would level out or drop. In the longer-run, this might be one of the most expensive courses the government could take.

A second alternative would be to try to continue or improve the present program. Again, the difficulties with this action should be evident. The constant pressure to cut back foreign exchange expenditures may well lead to decreased seed imports in the very near future -- a change that could be ill-afforded in view of the already low level of seed imports.[1/] At the very least, the pressures will lead to some uncertainty as to the amount to be imported in any one season. Timing of shipments from Holland has not made it possible to get imported seeds to the northwest district; if this is possible in the future, it will mean that the quantity available for the Dacca-Comilla area will have to be correspondingly reduced. This might create certain public relations problems. To avoid this difficulty, an effort might be made to increase total seed imports, but this action would run into the problems of exchange, timing, and uncertainty which we have already noted.

A third alternative would be to try to establish a breeding and/or a foundation seed program. This, however, would be next to impossible to do with any degree of success in East Pakistan at this time. These programs are difficult to operate under the best conditions in the most advanced nations. Virtually none of the technical prerequisities -- high level of plant breeding knowledge, highly isolated growing area, advanced insect and disease control methods, etc. -- exist in East Pakistan today.[2/]

1/ In West Pakistan, the expenditures for imported seed are expected to drop to the following levels compared with 1967/68: 1968/69, 77%; 1969/70, 44% (Implementation Plan for the West Pakistan Self Sufficiency Programme, 1965-70, Planning and Development Department, August 1967, p. 32).

2/ Our reservations are shared by a Dutch potato specialist (Winkel, op. cit. /see fn. 9, p. 10_7, p. 4).

Weather is a further problem. Weather data for nine locations in East Pakistan in 1963 are presented in Table 9. The relatively high temperatures and humidities year around and the variation in annual rainfall from 132 inches at Sylhet to 30 inches at Dinajpur are not conducive to conducting breeding/foundation seed programs. Also, most of the rainfall comes between May and September when the potato is not grown. These factors are recognized. There are no serious or immediate proposals for a breeding or foundation seed program.

On balance, then, we see that the alternatives to the proposed program are not very bright. If the ADC suggestion has difficulties attached to it, so do the alternatives. Even trying to maintain the status quo will involve problems. In this setting, then, the overall ADC proposal rates rather well.

Still, there are a number of facets of the projected program which could be examined further in terms of alternatives. We shall look at two in the following sections.

2. Sources of Seed Stock

The proposal doesn't specify any particular national source of seed stock, but there is some reason for believing that Holland might continue to play an important role. This centers about the fact that Holland is an aggressive and knowledgable exporter of high quality seed. Also, by now East Pakistan is familiar with the appropriate channels and suppliers.

This does not mean, however, that Dutch seed is necessarily the best for East Pakistan conditions. It was our observation that many of the Holland varieties were quite susceptible to the disease and insect problems endemic in East Pakistan. Through an intensified testing program, it should be possible to select more resistant varieties. But the lack of resistance, and the timing problem suggest that other sources of seed should at least be considered.

From a foreign exchange point of view, a natural source might seem to be West Pakistan. We were not able to obtain much information on the current seed potato situation in West Pakistan, but from all appearances it is not good.3/ There evidently is no program of any proportion currently underway, and if there were, local demand would be more than sufficient to absorb production. Also, West Pakistan still finds it necessary to import seed from Holland. Still, the country would appear to have a greater geographic potential for a seed potato program and some day it may come to pass. In the meantime, there is a stated problem of a shortage of appropriate freighters for ocean transportation (there is no overland ground link).

3/ Early efforts in West Pakistan were unsatisfactory (Eugene W. Whitman, "Seed Potato Production in East Pakistan," USOM, Lahore, February 1961, 8 pp.)

Table 9. TEMPERATURE, HUMIDITY AND RAINFALL AT DIFFERENT METEOROLOGICAL STATIONS IN EAST PAKISTAN, 1963

Name of Station	Temperature (^{o}F.) Maximum	Minimum	Humidity (percentage)	Rainfall (inches)
Chittagong A. P.	93	56	86	122.01
Comilla	96	51	84	107.37
Sylhet	97	53	82	132.04
Mymensingh	100	53	88	74.90
Dacca A. P.	100	53	83	77.98
Pabra	100	50	81	51.39
Dinajpur	102	48	78	30.39
Rangpur	100	50	84	77.56
Bogra	104	50	82	62.54
Province mean		44	83	79.61

Note: A. P. = Airport

Source: Meteorological Directorate, Chittagong.

What about other local alternatives? The traditional sources of seed -- India and Burma -- appear to be out of the picture for now. The political problems with India are well known. Burma has evidently been having severe internal problems with agriculture and will need all its own seed for some time. In any case, the seed from these areas, as noted earlier, was not of particularly high quality.

Going further afield, Australia and New Zealand would appear to be definite possibilities. They raise good seed and the difference in season should remove the existing timing problem. We discussed this alternative with a number of officials in Dacca and it was generally well received. The director of the AID/Agriculture Mission planned to look into the matter further.

There are undoubtedly other alternatives, but we did not have an opportunity to explore them. One question that has come up, however, concerns possible use of U.S. varieties. The problem with this, is that no one in the U.S. is particularly oriented to export of seeds. If some American varieties seemed promising, Holland would probably be willing to raise and in turn export them.

The importation of adaptable varieties that have immunity or a high degree of resistance to one or more of the four most common viruses -- latent mosaic, mild mosaic, rugose mosaic, and leafroll -- would greatly reduce the rapid rate of infection that now takes place in all the potato-growing areas of East Pakistan. Varieties are available in Europe, Australia, Canada, and the United States that possess resistance to one or more of the diseases mentioned above. The American variety Penobscot has field immunity to mild mosaic and a high level of resistance to leafroll. Any adaptable variety with resistance to one or more of the diseases that are so widespread in East Pakistan would help immeasurably.

For any of the alternatives, a stepped-up program of variety testing will be necessary. It is possible to suggest varieties which may be appropriate, but on-the-spot testing in East Pakistan will be necessary for verification.

3. Public or Private Operation?

We have assumed that the seed potato program would be entirely in the hands of ADC. What are the possibilities that part or all of the project could be handled by private enterprise? Actually, it is anticipated by ADC that at some point it may "disinvest," or sell one or more of the five operations to cooperatives or to private enterprise if they appear capable of carrying on the program. The receipts might then be used to set up a seed potato program in one of the areas not covered.

Could private enterprise enter at an earlier stage? Could it handle the multiplication and storage phases at the outset? We doubt it. Although our visit was too brief to be sure, we did not learn of any firms or groups with the management and technical know-how to handle a national

program of this scale and complexity.[4] At the regional or district level, only the cooperative at Comilla would seem to be a candidate, and it already has a program of its own.

How about breaking out the storage phase for the private sector? This is more of a possibility but would have a number of limitations. The cold storage business at present in East Pakistan is largely divorced from farming. The operators are general businessmen who have many financial interests. They are involved in cold storages solely for the substantial profit involved.[5] They are not interested in regulations, and the government fully realizes that it would have severe problems in enforcing any rules. We think it doubtful, therefore, that private storages would have the interest or desire to maintain the necessary quality standards for a program of this nature.

A corollary problem might be one of stability of supply. Potatoes are being held in quantity now simply because they offer, by far, the highest return. And where seed potatoes are stored by storage owners or speculators, it is simply because they are considered to be more profitable than table stock. Should the returns to seed storage drop, or other more profitable opportunities emerge, few operators would continue to hold seed for humanitarian reasons. This could lead to variations in supplies that would be incompatible with the program proposed. Insofar as it were still possible for farmers or groups to rent space, this would be less of a problem -- but they still would have no control over the disease level or what the owner or other renters place nearby in the storage room.

Because of the potential difficulties in having storage owners act as principal factors in the operation, it might be suggested that ADC take long term leases of existing storages and manage them according to their own standards. There are three major problems with this approach. (1) Storage is so profitable to owners at present that few would want to make arrangements of this sort; if they did, it would not be cheap for ADC. (2) The storages were not designed specifically for potato storage; they lack (a) forced ventilation, (b) outside air intakes, and (c) humidity control. (3) There is only very limited private storage capacity at present, and in prospect, in the important northwest region.

All this is not to say that it would be impossible to involve the private sector. But if the high and rather special standards needed in a seed multiplication program are to be maintained, we think that it would be clearly preferable to start with ADC ownership and operation of specially designed and located seed storages. This is, of course, no guarantee of success, but we think it will help facilitate initial operation of what will prove to be a sufficiently complex program.

4/ Even in the U.S., the multiplication programs are conducted under very close State supervision.

5/ The general climate is well discussed in "Role of the Private Sector - Problems of Private Investment in East Pakistan," Department of State Airgram, Dacca, No. A-130, November 21, 1967, 20 pp.' (Limited Official Use)

E. Location of Storages

If the general concept of the proposed seed potato program is accepted, one of the next questions concerns the specific location of the seed storages. It will be recalled (p. 44) that the tentative proposed locations for the storages were as follows:

Area	District	City or Town
Northwest	Rangpur	Rangpur
	Bogra	Shantahar
	Rajshahi	Rajshahi
Central-Eastern	Dacca	Munshiganj 1/
	Comilla	Chandpur

The specific locations of these districts and towns may be found on the map on p. ii. Are the proposed sites appropriate? Discussion of this point first relates to the distribution between districts, and then the more specific location within districts.

1. Location Between Districts

The locations by districts may be viewed in terms of relation to (a) production and (b) present and proposed cold storage capacity.

a. Relation to Production

The five districts listed as tentative storage sites are important potato districts: in terms of rank, they included the first four and the seventh among all districts in terms of total production in 1966/67. Their accumulated production was 53% of the provincial total. (See Table 4, p. 21)

The district ranking fifth in terms of 1966/67 production was Dinajpur. It is immediately adjacent to Rangpur, and could presumably make use of its potato storages (the town of Dinajpur is only some 30 miles from the town of Rangpur) or, to a lesser extent, those to the south in Bogra or or Rajshahi.

The district ranking sixth in production was Mymensingh, in the north-central area of the Province. This district would not be close to the proposed storages, except as the potatoes could be shipped west to the Rajshahi - Bogra - Rangpur storages, or south to the Dacca - Comilla storages.

The district ranking eighth, Noakhali, is just south of Comilla and could make some use of its storage. The same is true of Faridpur (No. 15), which is just to the west (and just south of Dacca).

The remaining eight districts, accounting for 21% of 1966/67 production, would be at a greater distance from the proposed storages. The most

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1/ Subsequently changed to Kessempur.

important district among the eight is Sylhet, in the northeast corner of the country, which ranked ninth in 1966/67.

All told, it appears that the five proposed storages will be relatively well located with respect to production by districts. The major uncovered districts will be Mymensingh and Sylhet, but the shift in the location of the Dacca storage from Munshiganj to Kessempur will place it much closer to Mymensingh.

b. Relation to Storage Capacity

The relationship to existing and proposed cold storage capacity should be examined next. The individual district figures have been presented in Table 4. On a aggregate basis, it may be seen that:

- The four northwestern districts of Rangpur, Bogra, Dinajpur and Rajshahi accounted for nearly 40% of 1966/67 potato production, but had only 13% of storage capacity in 1967 and will have only 6 to 10% in the future on the basis of construction proposed as of November 1967.

- The two central-eastern districts of Dacca and Comilla accounted for nearly 23% of 1966/67 potato production, but had 52% of storage capacity in 1967 and will have 59 to 63% on the basis of construction proposals.

- The two northcentral and northeast districts of Mymensingh and Sylhet, accounting for 15% of 1966/67 production, had only 6% of capacity in 1967 and will have from 6 to 10% of future capacity on the basis of construction proposals.

- The other nine districts vary but in general capacity will be roughly in line with production. The exception will be Noakhali, which, however, is close to Comilla.

There is, of course, some internal movement of potatoes so that the figures cannot be considered as precise. Even so, it is apparent that the northwest district is and will continue to be short on storage capacity while the central-eastern area will be in a much stronger situation. The Mymensingh-Sylhet area, next in importance, will be short on capacity.

Although this information suggests that there will be a particular need for additional storages in the northwest districts, followed by the northeast, it is less clear whether this means that there is an equally strong need for the seed storages compared to the central area. An initial reaction might be that the northwestern storages will face less competition in selling seed. True. But this also means that (a) a greater effort will have to be made to introduce the seed, and (b) there will be little capacity for storing the commercial production from the multiplied seed locally (the ADC storages, by definition, will not store any table stock). The reverse situation may be true for the two storages in the central area: there will be more competition, but the growers

will be aware of seed and will have space available for storing their output. How all this will balance out remains to be seen.

2. Location Within Districts

The proposed general locations within the districts have been noted. Four of the five cities or towns are located on waterways; only Rangpur is not so situated. Rangpur city is near the middle of the district, Shantakar is on the western border of Bogra and next to Rajshahi, Rajshahi city is in the southwest corner of the district next to India, Mushiganj is near Narayanganj in south central Dacca,2/ and Chandpur is in the southwest corner of Comilla.3/ In each case, there are only one or two other major towns.

At the time of our visit, some thought had been given to selection of specific sites within the towns by ADC, but definite decisions had not been made. It was thought that some of the storages would be located in industrial parks. In his study tour in February 1968, Mr. McKay of Bovay Engineers visited prospective sites for each of the storages. Three - Rangpur, Rajshahi and Bogra - were in EPSIC industrial estates. The fourth - Kessempur - was adjacent to an EPADC demonstration farm. The fifth - Chandpur - was not associated with EPSIC or ADC sites.

Although Mr. McKay evaluated each site from an engineering point of view, we have not reviewed them in terms of farm production. To do this, detailed information would be needed on the distribution of production within districts. This could be achieved by examining production data by subdistrict. Unfortunately, published information does not seem to be available on this point, though unpublished data could probably be traced down in Dacca. Time limitations did not permit us to explore this matter.

But the present location of production is not the only factor to be considered. Transportation facilities must be reviewed as well as the location of relatively "new" and isolated land for the production of seed potatoes in each of the five districts. Other things being equal, a location somewhere between the seed potato production and the location of commercial production would be desirable. The quantity of seed moving in and out of storage would be about the same; the difference is that the government will pay for transporting the potatoes to the storage, the growers will pay for transporting them away. But the storage cannot be so far away from the buyers as to make purchase inconvenient or expensive.

Final review of these matters will have to be made by ADC, possibly in cooperation with AID/Agriculture in Dacca. It may be, however, that there is such a limited range of acceptable sites from an engineering point of view that production considerations are not of equal importance.

2/ Subsequently changed to Kessempur, about 25 miles northwest of Dacca City.

3/ As we have noted in earlier chapters, the cooperative at Comilla city in the eastern portion of the district already has a modest seed program.

F. Recommendations for Implementation

If it is decided to go ahead with the proposed program, and the general location of the storages is set, there are a number of steps that might be taken to facilitate implementation. Many of these are implicit in what we have said in preceding sections. First we will present a few general recommendations, and then will list some specific horticultural practices.

1. Program Management

One of the principal problems in assessing the seed potato program is the almost complete lack of well-designed research. If the proposed program is to be successful, a greatly enlarged program of research is necessary. This should cover a wide range of agronomic and horticultural matters such as variety testing, fertilization, irrigation, insect and disease control. Additional study is also needed on the economics of potato production and marketing.

The research work might well be done in cooperation with the Directorates of Agriculture and Agricultural Marketing, and the Provincial College of Agriculture at Mymensingh. A broad-scale push is needed. In view of the loss of the central research farm to the new capital, the agricultural college would seem like a particularly good site for closely supervised field research.1/

Well-trained personnel will be a must for the effective operation of the program. An intensive training program should be established on seed potato production and storage, led by European and/or American specialists.2/ Both administrative and technical personnel should attend. It may be desirable to send one or two individuals abroad for a more extended period of study. A qualified foreign advisor, who we think should be attached to US/AID, should supervise the program for the first two years.

Because of the newness and complexity of the program, ADC should make every effort to see that its most capable personnel are assigned to the project, both in Dacca and in the districts. It will be particularly necessary to do as good a job as possible during the first few years of the program in order that the multiplied seed earns a good reputation.

A comprehensive extension and/or farm demonstration program would be most desirable to indicate the economic benefits of using improved seed

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1/ The American agricultural economics advisor at the University has some background in potatoes and might be particularly useful in this area.

2/ The Dutch Information Centre for Potatoes has expressed an interest in providing further assistance in this area (see Winkel, op. cit. /fn. 9, p. 10/, p. 9).

in conjunction with other improved practices.3/ Special attention should be given to the greater economic value of ADC seed over regular cold storage stock. This would necessitate the keeping of detailed records of costs and returns.

Some consideration should be given to liaison with the existing cold storages. It would be sanguine to expect warm relations at first, but a good public relations program could help avoid misunderstanding. At some point, the private storages may be receptive to advice and assistance, and ADC should be ready to give it. EPSIC, for instance, has expressed interest in eventually working out some kind of improved seed program. While the process might not lead to ADC's financial gain it could lead to improved seed -- which is, after all, the overall goal.

2. Production Phase

The imported tubers for seed multiplication will be certified and will have at most a very low percentage of diseased plants. To keep the stock as disease-free as possible, the areas selected for the multiplication program should be new to potato production and well isolated from present potato fields. The new areas, moreover, should be exclusively devoted to the increase of the imported stock.4/

In the variety testing program, emphasis should be placed on finding an adaptable variety with multiple disease resistance to the viruses commonly found in East Pakistan (presently the main source of the "degeneration" of the potato for seed). Any improvement in disease resistance would help immeasurably in maintaining higher yields from one seed generation to another.

Technical assistance of one horticultural supervisor and two assistants is to be provided for each seed-growing area. Particular tasks will be to: (a) see that diseased plants are rogued out; (b) make sure that plants are protected from insect and disease infection by the use of the proper fungicides and insecticides at the right time; and (c) insure maximum production by insisting that the best methods be used in preparing the land, planting, fertilizing, spacing, hilling, and irrigating.

A bookkeeping system should be adopted by the area supervisors to keep a record of the cultivators, their production, and the performance of the seed grown by them when it is replanted. Following the performance of the certified seed through two or three generations of multiplication is the only way that the program can be evaluated and adjustments made to

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3/ This will probably be particularly needed in the northwest districts where improved seed is not well known.

4/ The selected growers will, therefore, essentially have to learn production techniques from scratch. This will mean that there will be quite an educational load at first. But at least, growers will not have as many incorrect practices to unlearn.

improve weak spots. Also, in time, these records may show that certain districts can produce disease-free seed much more easily and more economically than others.

In reviewing specific recommendations, we shall use the same sequence of practices as in the opening section of this report where we outlined present horticultural techniques (pp. 5-10).

- Land Preparation. The preparation of a seedbed so that the soil is friable to at least two or three inches below the seed piece level would, we think, improve the growth rate and size of the plant. The seed pieces of most of the plants we observed were setting on firm and hardened soil at the lower level of the hill. Allowing more soil depth for root formation and growth should be very beneficial.

To avoid infection by Rhizoctonia and to get the plant above ground as soon as possible, the initial hilling should be very shallow. After each cultivation the hill should be gradually built up to its final height. This process will involve some cultural changes that the cultivators may not like -- but since ADC will be dealing with a new group of growers who have had little or no previous experience with growing the crop, this problem may be lessened.

- Seed Size and Spacing. The practice of selecting the smallest tubers for seed should be examined. Usually the smallest tubers are more likely to carry virus diseases than the larger ones. Selecting the smaller tubers for replanting increases the amount of diseased plants that will appear in the following crop. Using the largest tubers for seed is recommended in order to keep the disease transfer from one crop to another as low as possible, and to maintain yields as high as possible.

Better yields of larger tubers can be expected from larger seed pieces (1½ ounce) if the spacing between plants is increased to 12 inches between plants and to 32 inches between rows. This wider spacing would help the technicians in roguing out the diseased plants, and would allow larger hills to be built at planting time or at intervals after planting.

- Fertilizer. The quality, amount, and application of fertilizer have been previously considered (pp. 8-9). We will only review a few application techniques here. The current method of broadcasting the organic materials (cow dung and mustard seed oil) is practical and advantageous. Some changes are, however, needed for inorganics. Urea, triple superphosphate, and muriate of potash, along with a water-soluble nitrogen source, should be applied in bands at the seed level or slightly below and two inches from it at planting before the ridges are constructed. This practice should lead to increased early growth of the plant and improved yield. Placing the plant nutrients close to the plant roots in bands has proved very beneficial in many countries.

- Insect and Disease Control. Success in the control of diseases in seed multiplication will depend mostly on the ability of the technicians to determine what plants are diseased, and to remove them from the field at the earliest possible stage of growth. Growing of two crops

within one season should not be permitted in the seed area because of the carryover of the diseases from one crop to the other, and because of the lengthening of the period of potato growing within the area. The policy should be to plant the crop at the earliest date, to grow it to maturity as soon as possible, and to harvest and store it immediately.

Early harvesting by killing or pulling the vines may also be advantageous in keeping the amount of disease infection as low as possible. Early harvesting to prevent the spread of disease is not new; it is a common practice in the seed production areas of Holland and many other countries where aphids and leafhoppers build up rapidly during the growing season. The shorter growing period increases the chances of keeping the spread of virus diseases at a low level.

The use of Dithane or any other fungicideis recommended to control early and late blights. Application should begin as soon as the plants are 6 to 12 inches tall and should continue at intervals of seven or ten days until the crop is harvested.

Systemic insecticides are now available. These newer insecticides can be placed in the furrow at planting time. They are effective for six to eight weeks from the time of planting. After this growth period Malathion or some other insecticide should be sprayed on the foliage at weekly intervals up to harvesttime.

The buildup of blight epidemics or insect populations is best prevented by applying controls before the blight fungus or insect is outwardly evident. If one can see early or late blight or numerous aphids present in the field, then chances of control are very limited, especially for disease transfer by aphids from diseased to healthy plants.

- Irrigation. Land is commonly irrigated before planting when water is available. More frequent irrigation at intervals of seven to ten days, starting immediately after planting, would improve yields and hasten the growth of new plants. We understand that ADC plans to have several tube wells located within each seed-production area so water for irrigation should not be a problem.

The above suggestions for improvement of variety and horticultural practices are aimed at increasing imported seed to its maximum amount, in healthy condition, in the first year of multiplication. The second-generation yields resulting from this improved seed will, we expect, be far superior to any local seed that would be grown. As the improved seed is fed into the regular commercial potato-growing areas, a gradual improvement in quality and yield should occur.

A critical problem, as we see it, is to plant imported seed in isolation and grow a satsifactory crop as quickly as possible. Growing healthy plants to maturity in the shortest period of time is the best insurance for protection against disease infection. Early planting may be of some value in avoiding insect and disease problems (see Appendix C/1) and should be studied.

Potato foundation and seed certification programs are very sophisticated and are seldom successful except in temperate climates in the United States and in some European countries. Within the United States, the successful programs are located mostly in the north, never in the south. Even with these obvious advantages, there are chronic and new problems that challenge the ability to produce disease-free seed year after year. It would be unrealistic, therefore, to expect to carry out such programs in the tropics.5/

This does not preclude the successful multiplication and growing of acceptable seed for two or three generations in East Pakistan. One would expect some deterioration from one cycle to the next, but certainly the multiplied seed would be a marked improvement over the present situation in much of the country.

As the program progresses, the methods for conducting it should improve and should result in higher average yield per acre. Adjustments can then be made in increasing the base supply as experience dictates.

3. Storage Practices

We assume that the horticultural supervisor who is to work out of each storage during the growing season will assume related duties during the storage period. These would include supervision of: (a) the final selection of the seed potatoes -- either in the field or as the potatoes are brought to storage; (b) evaluation of condition of the stock during the storage season; and (c) inspection of potatoes as they come out of storage prior to planting.

It will be necessary to work out techniques and standards for each of these three stages -- e.g. the specific quality standards to be used in the initial acceptance of seed, the frequency and extent of inspection during the storage season, etc. When these are in hand, perhaps it would be possible to carry out some studies on the keeping qualities of different varieties, the influence of different temperatures, etc. In all these matters, the storage horticulturist would work under the close supervision of the Provincial potato specialist.

As actual storage management, supervision of financial accounts, mechanical operation, etc. -- would be in other hands, the horticulturist's storage-related chores should not be heavy. This would allow him time to carry out educational work with growers.

5/ An exception might be provided if there is some high and remote land available, as in northern India. But then there are problems of (a) different photoperiods, (b) transportation, and (c) timing (Appendix C/1).

IV. SEED POTATO STORAGE

In the early stages of the project proposal, it was expected that the seed storages would follow the same design as other potato storages in East Pakistan. However, it was soon recognized that the existing facilities -- as well as those under construction -- had certain characteristics which would limit their value for keeping high quality seed stock.

Hence it was decided to arrange for the services of a professional engineer to prepare preliminary designs for special seed storages. Bovay Engineers was engaged for this purpose, and Mr. Gene McKay assigned as project engineer. Mr. McKay visited East Pakistan in February 1968 and prepared a detailed report on his return.1/ In this chapter, we shall summarize the highlights of his observations and recommendations.

A. Present Practices

The current general practice is to store potatoes in burlap bags which are in turn stacked in piles on slatted wood racks. Coolant air is conveyed through ducts to the top of the room and then filters down through the produce. Room air is drawn into the evaporator and directed through a refrigerant coil. Temperature control is based on average room temperature or return air temperature.

Use of the bags causes problems. The potatoes located on the outside of the separate stacks or piles readily give up heat to the cold air. But the potatoes in bags within the stacks do not come into contact with the cold air directly, and must give up heat by conduction to the adjoining potatoes. The air within the space, however, has little velocity and consequently no propensity to permeate the stacks and come in direct contact with all the potatoes. Thus those potatoes stored deep within the stacks are insulated by the surrounding bags of potatoes and kept in a warmer condition. In an effort to minimize this effect, (1) the potatoes are restacked once or twice a season, (2) the space temperature is maintained lower than is desirable.

Problems with low humidity levels might be expected, but evidently haven't developed. The difficulties might be expected to stem from the facts that (1) cooling coils are maintained below the freezing point meaning that frost accumulates, lowering humidity, and (2) storages do not have good methods of raising humidity (the most that is done is to sometimes spray water on the wood racks or the floor). The reason that moisture loss is low is that the majority of the potatoes -- as noted previously -- do not come into contact with the cooling air, which would exert a drying effect.

1/ "Engineering Report on the East Pakistan Seed Potato Multiplication and Storage Project," Bovay Engineers, Spokane, March 1968, 73 pp.

Fresh air is not generally considered necessary, and because it constitutes a heat load on the refrigeration system, is kept to a minimum. Designs generally allow for several air changes each day from infiltration, opening the doors, etc., but it is doubtful that this much occurs, especially in the middle of the stacks. Since the potatoes stored are usually in a reduced state of vigor due to disease, they do not require as much oxygen as healthy potatoes and are less likely to suffer from the lack of ventilation.

Pre- and post-storage cooling is usually done. Even so, the high humidity forms condensate on the potatoes when they are removed from storage. The general practice is to dump the potatoes out of the bags and dry them off, often with the help of ceiling fans. Although this process is reported to be necessary to reduce rotting, no foundation in fact is known.

B. Proposed Storages

The proposed storages are quite different in concept from those now in general use. Instead of using bags, the potatoes will be stored in bulk. They will be placed loose in specially designed rooms. This is standard practice for both seed and table potatoes in the United States and should be appropriate for seed storage in East Pakistan. Since the ADC will own all the potatoes stored, individual grower segregation is not a requirement, except possibly for testing purposes (and this still can be done when desired).1/ Loose storage makes it possible to provide a more effective environmental control system.

The key element in this process is in the distribution of the cooling air. This is accomplished by routing the air from the supply fan to underfloor ducts which run the full length of the storage space. The top of the duct is formed by removable structural members which are spaced a set distance apart. The air, under pressure, passes out of the ducts and rises through the potatoes. Differential pressure causes complete distribution of air as long as there is sufficient pile depth and the proper spacing is established between the floor ducts.

The storage plant, which is to be designed to hold 1,000 tons, will be divided into four long rectangular compartments of 250 tons each. Each room will have independent controls so that it can be operated separately from the others. Thus, one compartment may be filled and kept at storage temperature while an adjacent compartment is being filled. This is not possible in the present single-room storages in East Pakistan.

The plant will be provided with refrigeration capacity to maintain the temperature of the potatoes between 38°F to 42°F. The potatoes nearest the cooling air supply (in the heart of the pile) will be at 38°F whereas those at the top of the pile will be 42°F. Since the potatoes which arrive at the storage will have an ambient temperature of as high as 85°F, the initial load on the refrigeration machinery will be much greater than

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1/ Small bins could be constructed for this purpose.

during the regular storage period. If the room is loaded in five days, it should be possible to reduce the temperature of the potatoes from 85°F to 40°F in four weeks. Lower temperatures than 40°F could be maintained after the drawdown period if desired.

While the proposed system will provide improved temperature control, more attention will have to be given to maintaining adequate humidity because the more rapid air movement will exert a dehumidifying effect. Each storage is to be provided with a portable humidity measuring device. Since it will be possible to operate the cooling coil above freezing, this potential source of drying should not be a problem. Humidity could be increased by letting in humid outside air, or by installing water spray nozzles in the discharge unit of the blower. Water also might be placed in the air ducts in the floor.

Fresh air is to be supplied on a constant basis to the storage space. The amount of air required is small in comparison to that being circulated, and can be varied depending on the operating conditions.

Filling of the room will be done with the assistance of a mechanical piler. Potatoes will be evenly piled to a depth of 12 feet. It is expected that the potatoes will be graded after storage. Equipment for speeding up this process is included in the specifications.

C. Plant Design

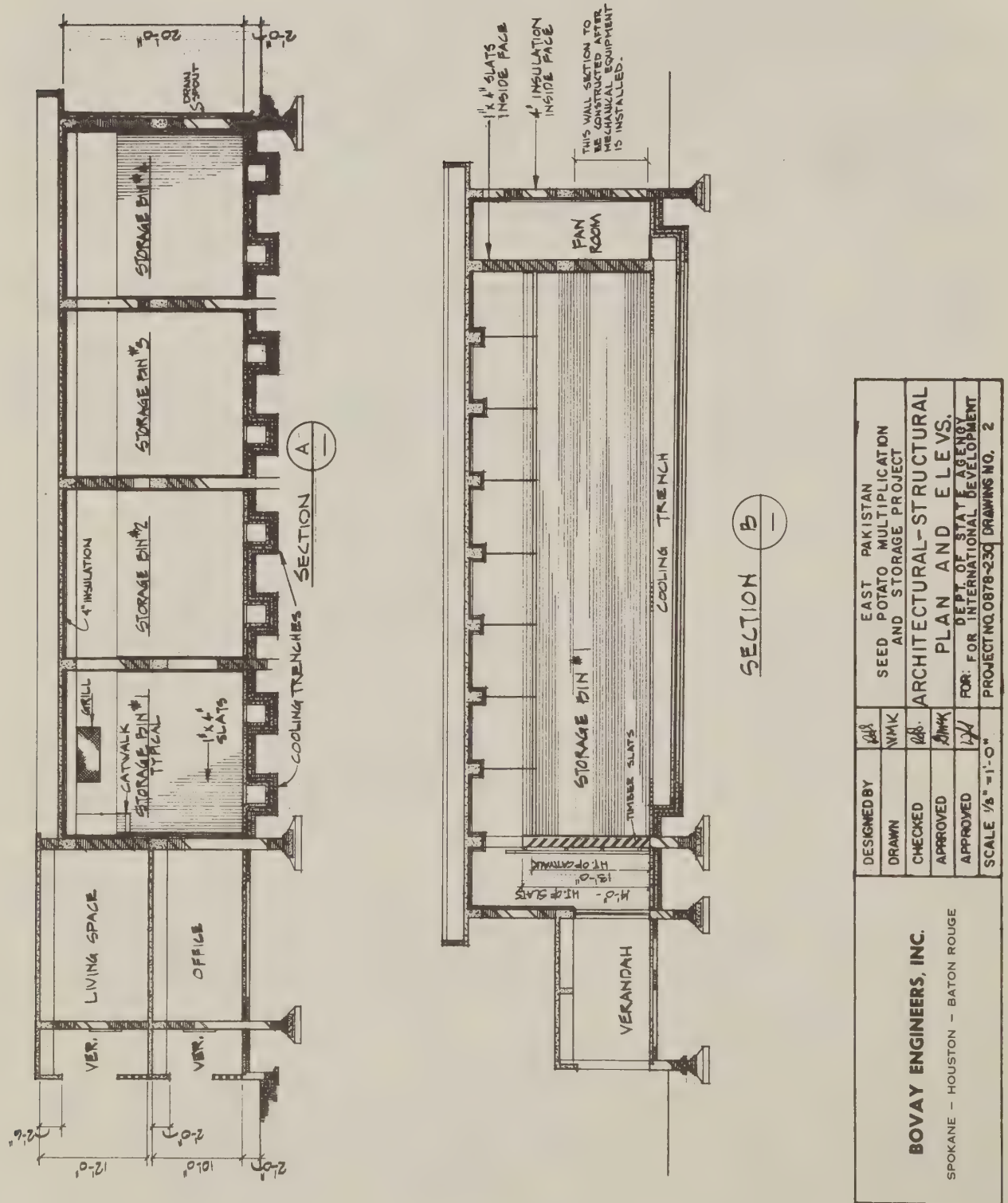
With the preceding concepts in mind, preliminary engineering drawings and specifications were prepared. In addition to building construction, mechanical and electrical systems are outlined. The latter two are presented in greater detail than is normal in order to insure the accuracy of the cost estimates. Still, final design services will be required.

It is proposed that a site measuring 240 by 160 feet (38,400 square feet) be provided. This space allows for the construction of an initial 1,000 ton plant with room for expansion to an ultimate of 2,000 tons. It also provides space for a transformer enclosure, cooling towers, living quarters, wells, etc.

The storage building itself is presented in Figure 7 . It will be noted that the floor layout has four rectangular storage rooms side by side, each with a fan room and access chamber. An extension of the storage area encompasses a mechanical room and three offices at ground level, and provides living space above. A wide, covered veranda runs along the offices and mechanical room.

The building will be constructed of reinforced concrete and brick. The framework, roof, and floor slabs will be reinforced concrete; walls will be brick covered with plaster. The storage room walls will be designed for horizontal pressures induced by the potatoes. Two cooling trenches will run the length of each storage room with a connecting trench in the fan room. Catwalks will be provided for each room; these will allow inspection of the stored potatoes and provide access for the workmen during the filling phase.

Figure 7. PROPOSED FLOOR PLAN OF OFFICE AND STORAGE AREAS



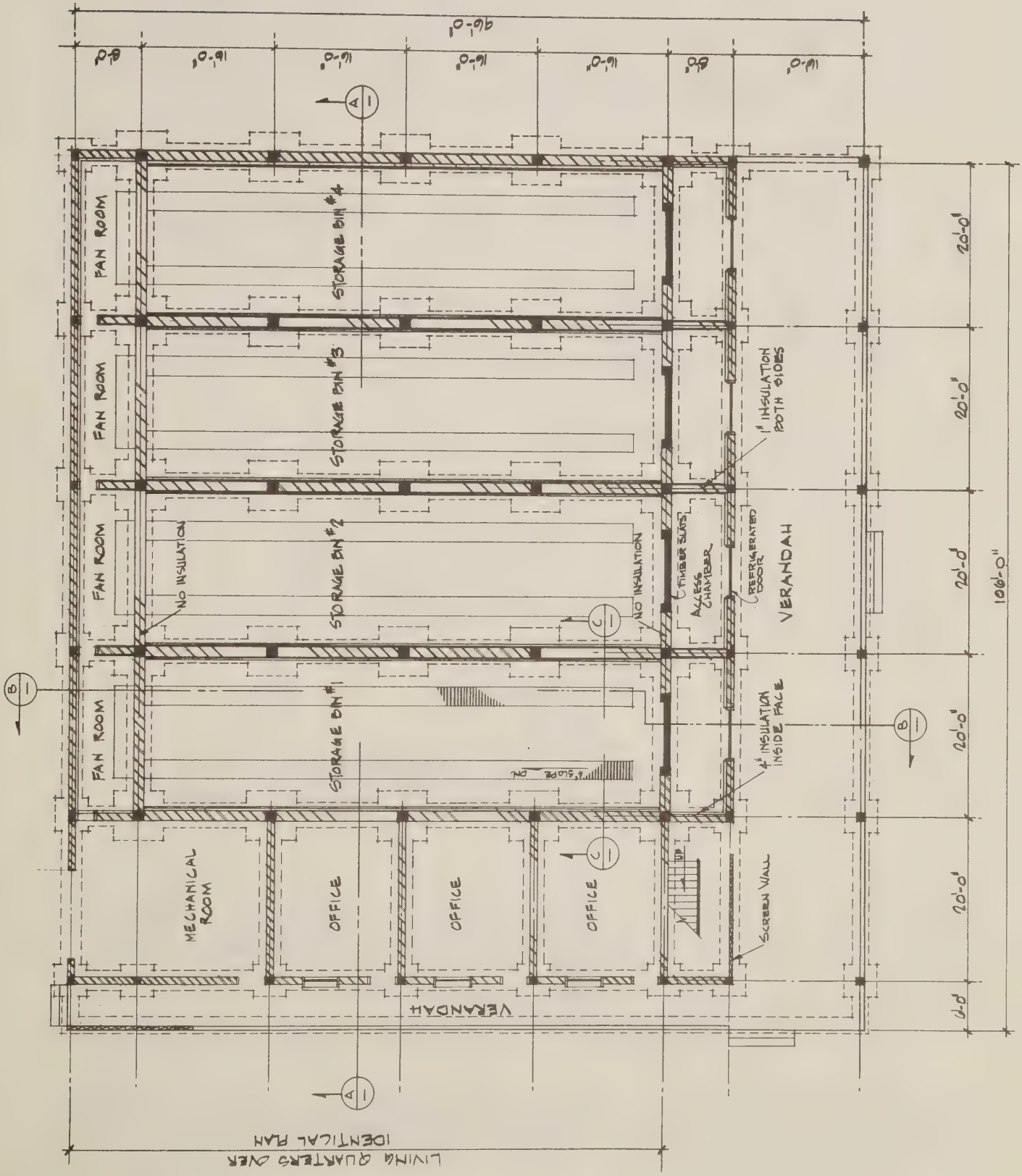
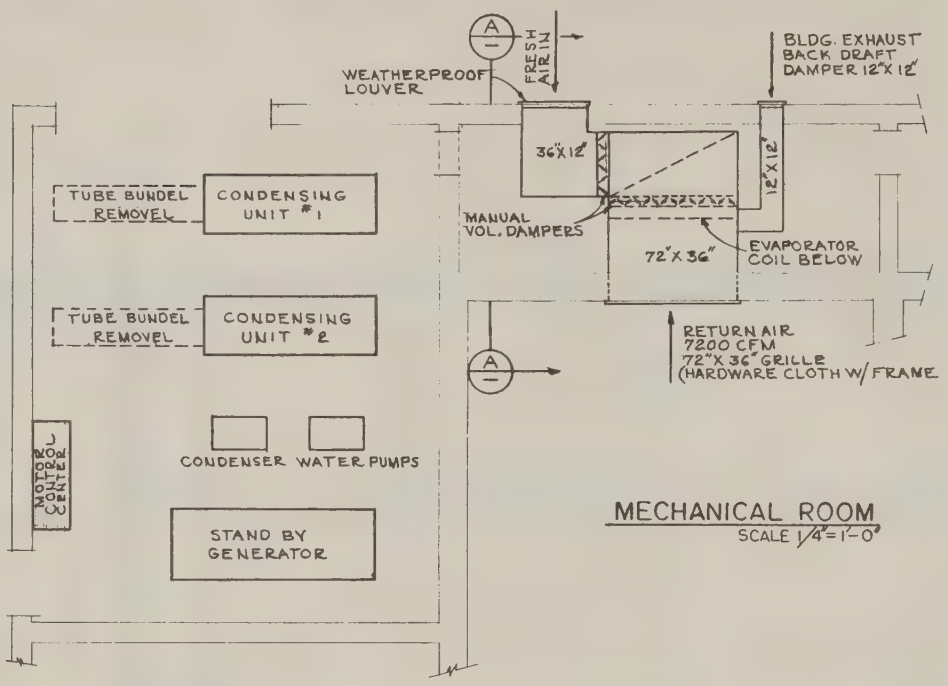
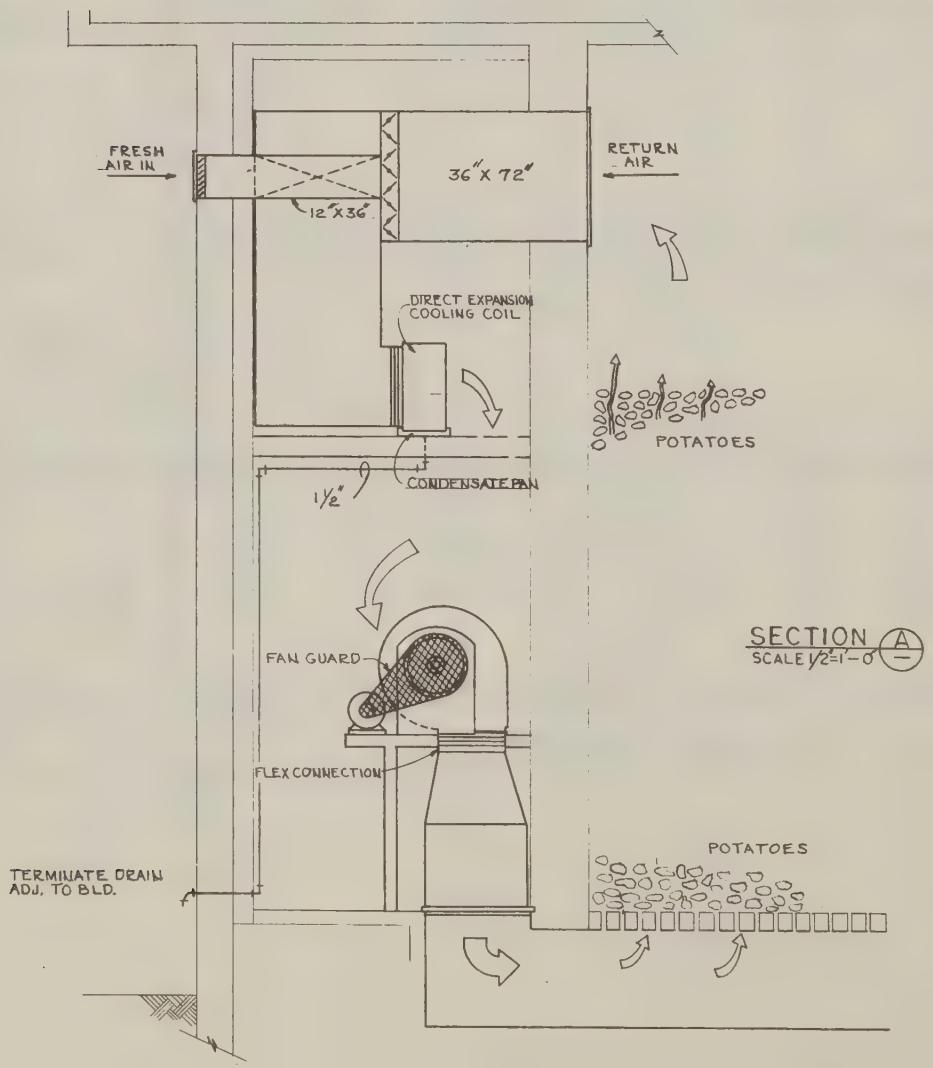

LIVING QUARTERS OVER
IDENTICAL PLAN
VERANDAH
MECHANICAL ROOM
OFFICE
OFFICE
OFFICE
SCREEN WALL
4" INSULATION INSIDE FACE
REFRIGERATED DOOR
ACCESS CHAMBER
TIMBER SLATS
1" INSULATION BOTH SIDES
VERANDAH
NO INSULATION
NO INSULATION
STORAGE BIN #1
STORAGE BIN #2
STORAGE BIN #3
STORAGE BIN #4
FAN ROOM
FAN ROOM
FAN ROOM
FAN ROOM
20'-0"
20'-0"
20'-0"
20'-0"
20'-0"
106'-0"
16'-0"
16'-0"
16'-0"
16'-0"
16'-0"
8'-0"
8'-0"
96'-0"

Figure 8. PROPOSED DESIGN OF MECHANICAL AND FAN ROOMS





The mechanical equipment room is located in the rear, left corner of the building. It will contain two freon compressors. The cooling room in the rear of each storage bin will contain the fan and cooling coil for that bin. The fans will draw a mixture of return air (7,080 cfm) and outside air (120 cfm) which will be distributed downward to the air trenches and distributed the full length of the pile. The air will be forced up through the slots provided in the trench cover. Exhaust air is relieved to the outside through a backdraft damper installed in the exterior wall. (See Figure 8.)

Electric power for all five sites will be supplied by the East Pakistan Water and Power Development Authority. Each storage will be equipped with a diesel driven auxiliary generator to provide emergency power in the event of power interruption.

While much of the material for the building can be purchased in East Pakistan, other items will have to be obtained abroad. Imported items will include: insulation, insulated doors, mechanical refrigerating equipment, much of the piping, and much of the electrical gear.

Although final design and working drawings for the building and ancillary facilities should be done by East Pakistan engineers, final design and drawings for the mechanical and electrical systems should be done by American engineers. Because the storage buildings will be unlike any presently in existence, it is recommended that an American engineer be assigned to serve as project consultant for about nine months. He would function as an advisor to the ADC project engineer and would assist on such matters as: selection of a Pakistan consulting engineering company, review of drawings and specifications to insure that the concept is maintained, preparation of tender documents, aid in plant start-up, etc.

D. Project Schedule

Any sizeable construction project involves a complex array of intertwined steps which must be planned ahead if expected completion dates are to be met. A normal schedule for a project of the sort proposed would be at least a year. This would allow for final design, construction, and start-up and testing.

Assuming the storages were to start up in February of one year, the project should start by at least February of the preceding year. In terms of the proposed project, to meet a February 1970 starting date, final design should be completed by early 1969. The final design stage, would, of course, have to be preceded by other administrative decisions regarding the project, completion of loan arrangements, etc. Thus, early 1970 would appear to be the earliest practical starting date for the storages.

The schedule could be compressed somewhat. But it is very doubtful that it could be tightened sufficiently to provide for an operational starting date in early 1969. To do so would involve grave risks and is definitely not recommended.

V. FINANCIAL ASPECTS

Analysis of the financial aspects of the proposed seed potato program is both a complex and uncertain task. It is complex because of the unique nature of the project and the intertwining of the multiplication and storage phases. While the construction and operating costs of the storage can be rather closely estimated, the costs of and the returns from the horticultural phase of the program are considerably less certain. In this chapter we shall summarize the highlights of a more detailed financial study of the project.1/

A. Types of Appraisal

There are two main conceptual ways of evaluating a project of this nature: financial and economic. The financial analysis views the proposal in terms of costs and returns to the Agricultural Development Corporation. The economic analysis views the proposal more in terms of its costs or returns to the economic development of East Pakistan.2/

Generally the economic results of public agricultural projects are more important than the financial results. A World Bank report has stated that the credit worthiness of agricultural projects does not depend entirely on their self-liquidating character. It adds, moreover, that self-liquidation is seldom insisted upon in practice.3/ Still, both approaches play a role in evaluation of the potato project.

The analytical process used here, then, is to start with a financial appraisal and then move into a broader economic appraisal. The costs developed for the financial phase are used in the economic appraisal. The main difference is in the treatment of benefits.

B. Financial Appraisal

Financial data pertaining to the project is provided by the study team reports as well as by a project proposal prepared by ADC.1/ In this section we will first examine costs, then returns, and finally the balance

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1/ "East Pakistan Seed Potato Multiplication and Storage Program: Financial Aspects," International Agricultural Development Service, April 1968, 19 pp.

2/ For a discussion of the role of the potato in European development, see Redcliffe N. Salaman, The History and Social Influence of the Potato, Cambridge University Press, 1949, particularly Chp. 27, "The Relation Between Potato and Bread Consumption in a Rapidly Growing Population," pp. 537-542.

3/ Herman G. van der Tak, "The Evaluation of Agricultural Projects: A Study of Some Economic and Financial Aspects," International Bank for Reconstruction and Development, Economic Department, Report No. EC-128, May 1964, p. 29.

1/ "Scheme for Multiplication, Preservation and Distribution of Improved Seed Potato," Agricultural Development Corporation, Dacca, April 1967.

between the two. The data will be in terms of one storage.

1. Gross Costs

The costs involved with the project are of two main types: non-recurring and recurring. Non-recurring costs are perhaps more readily identified as capital costs; recurring costs as operating costs.

a. Non-recurring Costs

The capital costs of the project center, of course, about the storage itself. These have been carefully calculated in the Bovay study. There are several categories, including such items as land, building, machinery, equipment, engineering costs, and a contingency fund. The total cost per storage is estimated to be Rs. 1,146,900 for expenditures in Pakistan and $72,200 for the cost of imported materials (the rupee price includes the cost of duties and taxes on the imported items). If the dollar figure are converted to rupees the total cost is Rs. 1,491,000; if the rupee cost is converted to dollars the total cost is $313,000.2/

b. Recurring Costs

The recurring costs cover both the operation of the storage and of the horticultural program itself. A combination of sources is used to derive these figures and they are considerably less precise than the non-recurring costs.

The total cost for each storage is estimated at about Rs. 897,000 the first year, Rs. 972,000 the second, and Rs. 949,000 the third. The figures include foreign exchange expenditures, which will go primarily for the purchase of imported seed (Rs. 100,000 or $21,000); lesser amounts will go for a shared cost of the foreign agricultural advisor the first two years and for spare parts and equipment.

c. Total Costs

ADC has estimated its overhead charge as 2½% of all the above costs. This would bring the total costs for all costs per storage to about Rs. 2,447,000 ($514,000) the first year, Rs. 996,000 ($209,000) the second, and Rs. 973,000 ($204,000) the third.

2. Gross Returns

Gross returns are influenced by both price and quantity of potatoes. The price of potatoes is calculated as Rs. 38/md., both for the imported and multiplied seed potatoes. The quantity sold the first year will consist only of 3,600 mds. of imported stock;3/ during the second season both

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2/ Conversions on the basis of $1.00 = Rs. 4.762.

3/ This is the planting figure used by ADC. We think that the actual sales figure might be higher (see Table 7, p. 47).

imported and multiplied stock (29,250 mds.) will be available, bringing the total to 38,850 mds. per storage.

Total returns, therefore, are estimated to be Rs. 137,000 ($29,000) the first year and Rs. 1,248,000 ($262,000) the following years. At the end of the program, there would be a final carryover stock of multiplied seed worth Rs. 1,111,000 ($223,000). Actual returns the first couple of years may be less than those cited here.

3. Net Costs and Returns

The gross costs and returns can be summarized as follows for one storage:

Year	Gross Costs	Gross Returns	Net Costs or Returns	
1	Rs. 2,447,000	Rs. 137,000	-Rs. 2,310,000	($485,000)
2	Rs. 996,000	Rs. 1,248,000	+Rs. 252,000	($ 53,000)
3	Rs. 973,000	Rs. 1,248,000	+Rs. 275,000	($ 58,000)

These figures are subject to two sets of adjustments. First, as noted earlier, the capital cost included duties and taxes paid on imported machinery and equipment; if this is deducted, the cost in year 1 is lowered by about Rs. 177,000.[4/] Secondly, it is expected that three of the costs -- the horticultural staff, the premium to growers, and the ADC overhead charge -- will be provided as a gift; if these are deducted, the costs are lowered by Rs. 189,000 in year 1, Rs. 144,000 in year 2, and Rs. 129,000 in year 3.[5/] If these two sets of costs are deducted the net costs and returns would be -Rs. 1,944,000 ($434,000) in year 1, +Rs. 406,000 ($85,000) in year 2, and +Rs. 404,000 ($85,000) in year 3.

How do the adjusted figures look in terms of a profit and loss analysis? A very rough calculation, using ADC interest and depreciation rates, suggests that annual profits after the first year or two might average around Rs. 200,000. If these profits were used to pay off the capital cost of nearly Rs. 1,500,000, it would take another seven to eight years to reach the break-even point.[6/] If allowance is made for the start-up period, a total of ten years might be appropriate. Since the storage life is placed at 20 years, this suggests that the program would be economically feasible (though the return would not be high by normal commercial standards in East Pakistan).

4/ This includes a corresponding deduction in the contingency fund.

5/ Financing of the foreign advisor has yet to be arranged. It is not known whether he will be included in the ADC gift, but a pro rata share (Rs. 25,000) has been so counted for the first two years.

6/ If duties and taxes had to be paid on imported equipment, several years would be added; if the grant did not materialize, the total time period could be considerably longer. The time could also be extended if severe program difficulties, unusually bad weather, etc. should materialize.

C. Economic Appraisal

In performing an economic appraisal, a different view is taken of benefits. Instead of financial returns to ADC, the concern becomes one of financial returns to growers from using improved seed. The first question is whether the proposed program is the cheapest way of providing a given quantity of improved seed. The second question concerns the balance between the costs and social returns of the proposed program.

1. Assessment of Alternatives

In East Pakistan there are effectively only two practical ways of obtaining a given quantity of improved seed: (a) through import of the total amount, or (b) through the proposed program of importing and multiplication.

How would costs compare over a 20-year time horizon? Costs of the total import program would total nearly Rs. 107,900,000 ($22,660,000), of which Rs. 71,000,000 would represent foreign exchange cost. Unadjusted costs of the multiplication program would total about Rs. 105,200,000 ($22,113,000), of which Rs. 11,900,000 would represent foreign exchange cost. On this basis, the multiplication program would cost slightly (2.5%) less.

But one very important factor has been overlooked: the real value of foreign exchange is much higher than the formal exchange rate. As one economist recently put it:

> ... it is almost universally recognized in Pakistan that spending foreign exchange is a different thing ... the real value of the foreign exchange to the economy is higher than the official value of 4.7 rupees to a dollar.[1/]

The real value of foreign exchange -- sometimes referred to as the "shadow price" -- is currently estimated at about twice the exchange rate. This substantially influences the cost relationship between the two seed programs.

When the costs are recalculated using the "shadow price" of foreign exchange, the total cost of the total import program increases to Rs. 178,900,000, or the equivalent of $37,570,000; while the cost of the import-multiplication program is increased only to Rs. 117,200,000 or $24,600,000. Thus the cost of the import-multiplication program is nearly 35% less expensive when the shadow price is considered (or to put it differently, the total import program would be over 50% more expensive).

The differential could be widened or narrowed in several ways. If the cost of taxes and duties on imported equipment -- essentially an internal government transfer of funds -- is deducted from the multiplication program,

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1/ W. Eric Gustafson, "Introduction to Cost-Benefit Analysis," Cost-Benefit Analysis (ed. A. T. Kahn), National Institute of Public Administration, Lahore, 1965, pp. 18-19.

the differential widens. On the other hand, problems in the multiplication program could reduce the gap.

Still, the multiplication program clearly is the lower cost alternative.

2. Costs and Grower Returns

The previous section has indicated that the costs of the multiplication program over a 20-year period (excluding duties and tariffs on the original machinery) might be nearly Rs. 117,000,000 ($24,500,000) if a shadow price is included or Rs. 105,000,000 ($22,000,000) if it is excluded. How do these costs match up with returns to farmers? The potential benefits of the program to farmers were listed earlier in this report (pp. 51-53). Some are quantifiable, others are not.

a. Quantifiable Benefits.

Increased net returns can accrue in two different ways: (1) income to those who did not raise potatoes before but who are enlisted to multiply seed potatoes, (2) income to regular growers who use improved seed. Returns are based on marginal increases of production above what are obtained under the existing program (1967 level of imports).

(1) Seed Growers

When the project is underway, seed potatoes will be grown on 2,000 acres. If this represents new production and the average net return is Rs. 600/acre (p. 49), the net value would be $252,000. In reality, allowances should be made for the possibility of (a) lower acreage, (b) lower net return, and (c) a substitution of potatoes for some other form of production. A cut of 1/5 would leave $200,000/yr.

(2) Regular Growers

The returns to these growers consist of two phases: those who use the fresh ADC seed as it comes out of storage; and those who use subsequent generations as they are held in regular storage.

- ADC Storage Seed. The precise increase in return would vary depending on whether growers have been using the (a) native, (b) second generation cold storage, (c) imported seed. The real picture is probably a mixture. Taking the two extremes and allowing for cost of production, the net increase in value to growers might be Rs. 3,650,000 or $766,600.

To be practical, this figure might be cut by 1/4 to represent the possibility of higher costs of production and the fact that some of the growers using the multiplied seed will have switched from "improved" cold storage seed. This would still leave a figure of Rs. 2,738,000 or $575,000.

- Regular Storage Seed. It is very difficult to judge the effect of subsequent generations on ADC seed on farm returns. If, on a purely arbitrary basis, it is assumed that the overall effect on production is 1/4 that resulting from the direct use of ADC seed, the increase in

value might be roughly Rs. 1,300,000 or $273,000.

(3) Total

While the value figures cited here are very rough, they do indicate that the new net farm value of the multiplied seed could be very substantial -- perhaps approaching $1,000,000 a year, or $20,000,000 over 20 years.2/

These figures understate the benefits in that they refer to marginal increment to regular growers above what they are getting under the present program. If the basis for comparison was suddenly no program, the returns would be approximately over twice as high -- say $40,000,000 over the 20-year period.3/

b. Non-Quantifiable Benefits

The non-quantifiable benefits of the seed program center about (1) the stabilizing effect the ADC program will have on the price and quality of other seed -- which may mean other growers will get better seed at lower prices, (2) possibly higher prices to growers in view of the fact that improved varieties have generally brought higher prices than native varieties, (3) improved distribution of improved seeds to the northwest districts, and (4) better timing of seed availability. Though a price tag cannot be put on these factors they may in total be of considerable value.

3. Summary

In total, the economic appraisal -- though necessarily rough -- has indicated that:

- the proposed multiplication program could produce a given quantity of improved seed at perhaps 1/3 less cost than if they were all imported, if the "real" value of foreign exchange is considered.

- the proposed program might cost $22 to $25 million over the course of twenty years, but the returns to growers could be as much as $40 million.4/ The value of non-quantifiable benefits could raise the figure even higher.

2/ It would be more precise to say that the benefits would total over $1 million a cycle, the returns being spread out as follows: first year, seed growers; second year, regular growers (first round); third year, regular growers (second round).

3/ The proposed program is expected to result in the production of 142,000 mds. of improved seed (Dutch import equivalent). This would be an increase of 62,000 mds. over present import levels of Dutch seed of 80,000 mds. It would be an increase of 142,000 mds. if regular imports of Dutch seed were discontinued.

4/ Assuming the basis of comparison is no program; the return figure would be $20 million compared to the present program.

VI. CONCLUDING REMARKS

Improvement of seed quality is of critical importance for the potato industry in East Pakistan. As traditional approaches to seed improvement are not open, unconventional techniques must be tried. The East Pakistan Agricultural Development Corporation has proposed a unique project for the multiplication and storage of imported seed stock. A key feature of the proposal is the construction of five special seed storages -- for which AID loan funds are being sought to cover the foreign exchange cost.

Evaluation of the proposal is difficult. The project is both unconventional and complex. But given present and anticipated conditions in East Pakistan, we think that the program is desirable, logical, and feasible. The production or seed multiplication phase of the project will, however, probably be more difficult than the storage phase. And while the financial returns to ADC may not be high by East Pakistan standards the broader economic and social returns should be substantial.

But much remains to be done if the proposal is to be satisfactorily transformed into reality. Two of the most important steps center about staffing and scheduling. Successful implementation of the program will, to a large extent, hinge on the assignment of highly competent people to the project -- both in Dacca and at the storages. Personnel must, moreover, be provided with appropriate technical training. Technical assistance should be provided at the onset by a qualified foreign engineer and a potato horticulturist.

Careful scheduling of operations is vital. In addition to the engineering aspects of storage construction, many other matters must also be programmed. Aside from administrative matters concerning clearances and financing, these might fall into three main areas:

- Variety testing and research. Selection of locally adapted and disease-resistant imported varieties will be of basic importance to the success of the program. Unfortunately, little testing of various foreign varieties has been done in East Pakistan. There is, therefore, an urgent need to greatly step up selection and research programs as soon as possible.1/

- Multiplication program. This is a complex area and work should start at least a year before the first imported potatoes are to be planted. The first step would be the selection of staff, which in turn, would assist in matters such as the following: Selection of growing aréas and growers, establishment of grower training programs, arrangement of credit, lining up of production inputs (fertilizer,

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1/ Foreign technical assistance for this phase of the project would be desirable and need not necessarily be provided by the same person who serves as advisor to the multiplication program. The program advisor could, moreover, take over this work when he arrives.

insecticides and pesticides, etc.), working out of inspection program, setting up of distribution of imported seed to farms and transportation to storage, etc.

- Use of multiplied seed. Farm demonstrations showing the value of imported seed to regular growers should be conducted in the northwest districts the season before the multiplied seed becomes available from the ADC storages. Prospective seed growers may need to be educated as to how to raise the improved stock to best advantage. Distribution methods will then have to be worked out -- not all farmers will be able to, or will want to come to the storage to buy the seed. Several distribution centers may have to be set up in the district.

It should be quite clear that many important tasks need to be carried out before the multiplication program becomes operational. The program is sufficiently new and involved that it should not be unduly rushed. A good start is critical.

If this task seems important now, it will be even more so in the future. As supplies of food grains -- particularly those of rice -- rise to acceptable levels and incomes improve, there will be an increasing demand for the products of a more diversified agriculture.

VII. APPENDIX

A. Partial list of Personal Interviews in East Pakistan:
(in Dacca, unless otherwise specified)

Agency for International Development, Agriculture Division
- Alan Goodbarry, Chief Agricultural Officer
- Keith Byergo, Extension Advisor
- Jim Shepard, Program Advisor
- Rudy Isler, Agricultural Economist
- Clayton Ingerson, Area Extension Advisor (Rangpur)
- Arthur Thivierge, Loan Officer /Capital Development Division/
- Donald Larson, Statistics Advisor /Public Administration Div./

East Pakistan Agricultural Development Corporation
- A. A. Aziz, Manager, Farms and Seeds Division
- Abdul Hakim, Deputy Manager, Seed Farms
- A. M. Ahmed, Program Planner
- N. A. Khan, Manager, Purchases
- A. S. M. Kamaluddin, Chief Horticulturist

Directorate of Agriculture
- Musammil Haq, Deputy Director
- Syed Hemayetuddin Ahmed, Deputy Assistant Director
- Kamaluddin Ahmad, Horticulturist

Directorate of Agricultural Marketing
- Md. T. Hussain, Director
- Md. S. V. Shikder, Research Officer

East Pakistan Small Industries Corporation
- Frank Turner, Senior Advisor
- Arthur Toogood, Training and Engineering Advisor
- Abdulah Khaled, Deputy Manager, Marketing

Industrial Development Bank of Pakistan
- Ahmed Jamal, Public Relations Officer

Pakistan Industrial Credit and Investment Corporation
- K. A. Rashid, Chief Manager

East Pakistan Agricultural University (Mymensingh)
- F. L. Underwood, Agricultural Economics Advisor
- Aminul Islam, graduate student

B. Pictures of the Potato Industry in East Pakistan

Dr. R. V. Akeley (right) examines potato plants near Chittagong.

Native potatoes from home storage on sale in Chittagong.

Potato cold storage in Comilla

Cold storage potatoes being loaded on boats in Fatullah for transportation to market.

Recently-arrived Dutch seed potatoes in storage yard in Munshiganj.

C. Potato Research in Other Developing Areas

1. Asia

India has had a program of potato research for some 30 years. A Central Potato Research Institute is located in Simla in the north central portion of the country. Much of the work that has been done is reported in the following publications:

- Pushkarnath, Potato in India: Varieties (India Council of Agricultural Research, New Delhi, 1964, 466 pp.).1/

- The Indian Potato Journal (Indian Council of Agricultural Research, New Delhi, biannual, 1959 to 1965).2/

Of particular relevance is a recent report by Pushkarnath on "Seed Potato Production in the Sub-Tropical Plains of India" which appeared in the American Potato Journal (December 1967, pp. 429-441). The problem in India is much like East Pakistan's: "Just three seasons of successive culture of a variety in the plains can reduce its yield potential by about 50%." Because of a number of problems involved in briging in seed from the high areas, emphasis was placed on developing a seed program on the plains.3/ It was noted that many of the existing diseases and viruses are transmitted by aphids, which reach a sharp peak in numbers in February. Since it is possible to plant and harvest an early autumn crop by early January in India, this crop might be relatively disease-free and good for seed. Initial test results have been promising.

This method should be studied further for possible use in East Pakistan. Offhand, several technical and economic questions come to mind. Would the aphid population build up the same way and to the same degree? Would it be possible to get a crop planted and harvested in time to avoid the build-up? How much of a sacrifice would there be in yield? What would be the extra cost of starting the storages up one to two months earlier? In any case, the matter is well worth investigation.

1/ National Agricultural Library (USDA) call no.: 75, p. 96.

2/ National Agricultural Library (USDA) call no.: 75.8 In. 2. In 1966, the Potato Journal was absorbed into the Indian Journal of Agricultural Science.

3/ A recent AP news item from Patna, however, indicates that a high-yielding hybrid has been developed which "can be grown on the lower slopes of the Himalayas and in the torrid deserts of Rajasthan State" ("Hybrid Potato Grown," Washington Post, May 6, 1968, p. A 13).

2. Latin America

The Rockefeller Foundation has, for several years, sponsored an Inter-American Potato Improvement Project. Nations which currently have progressive improvement programs include Mexico, Guatemala, Costa Rica, Panama, Colombia, Ecuador, Venezuela, and Peru. Details are provided in The Rockefeller Foundation Program in the Agricultural Sciences (Progress Report: Toward the Conquest of Hunger, 1965-1966, New York, pp. 126-135).

A recent report from the Foundation states that "At the request of national leaders in Asia, the Foundation's potato specialist /Dr. John S. Niederhauser/ will now work on an international basis through the International Potato Improvement Project headquartered in Mexico" (The President's Review and Annual Report, 1967, New York, pp. xvii, 45). Such assistance could prove to be most helpful to East Pakistan.

An intensive and comprehensive potato program is underway in Peru under a contract between AID and North Carolina State University. Details are provided by Richard L. Sawyer, co-leader of the program, in a recent article in The Packer (Kansas City, December 30, 1967, Sect. C, pp. 26-27).

The potato industry in Brazil is reviewed in detail in "Economic and Engineering Study: Marketing Facilities for Grain and Tuberous Crops, Brazil" (a study conducted for AID by Weitz-Hettelsater Engineers, Kansas City, Volume II, August 1963, pp. 661-718, 838, and drawing number AD-32).4/

3. Africa

A conventional potato breeding program is now underway in Nigeria under AID auspices. Details on the results of variety tests are provided in R. V. Akeley, et al., National Potato Breeding Program, 1967; 38th Annual Report to Cooperators, (USDA, ARS, March 1968, pp. 158-160).4/

3/ Only limited numbers of this publication were prepared and it is not available for general distribution.